

**Welcome**

# A little about the speaker...Tim Hall



- Born & raised in West Virginia
- Graduate of West Virginia University (WVU) School of Engineering with a BS Mechanical Engineering

*Lets Go Mountaineers!!*

- Been involved in the space industry for 18+ years
- Space career includes working 30+ Space Shuttle and International Space Station (ISS) Missions in the Mission Control Center
- Currently Chief of the Extravehicular Activity (EVA) Operations Branch





# What's Going On Now At NASA?

# Human Spaceflight....



BEAM (Bigelow  
Expandable  
Activity Module)  
Install



SpaceX  
Dragon



Orbital Sciences  
ATK Cygnus



Expedition 46



Expedition 47



# Commercial Resupply Services 2 (CRS2) Awarded



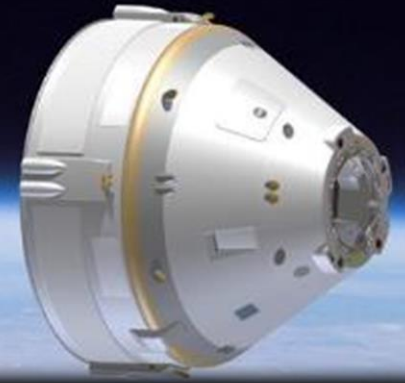
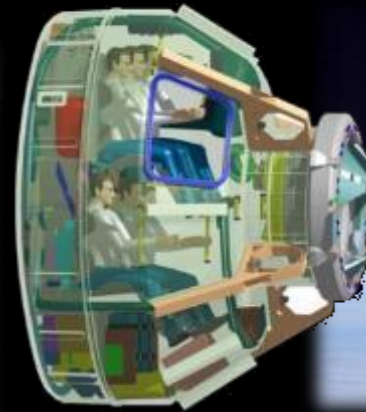
- Prime suppliers of cargo to ISS
- 3 companies awarded for 2<sup>nd</sup> round
  - Orbital Sciences Cygnus
  - SpaceX Dragon
  - Sierra Nevada Dream Chaser



# Commercial Crew



1. SpaceX
2. Boeing



Boeing CST-100

SpaceX Dragon Capsule

Atlas V



Dragon Interior



Falcon 9 Rocket

# EFT-1 = Exploration Flight Test -1 Success!



- 1<sup>st</sup> mission (unmanned) for Orion (MPCV)
- Tested heat shield at high entry velocity
- Used Delta IV Heavy rocket



2014  
EXPLORATION FLIGHT TEST 1

20,000 MPH  
Re-entry

## EXPLORATION FLIGHT TEST ONE

TWO ORBITS + 20,000 MPH ENTRY + 3671 MILE APOGEE + 28.6 DEGREE INCLINATION



# MPCV – Multi-Purpose Crew Vehicle “Orion”



- Second test flight in 2018 (SLS)
- First Manned Mission 2021 (SLS)



# NASA Heavy Lift Vehicle - SLS



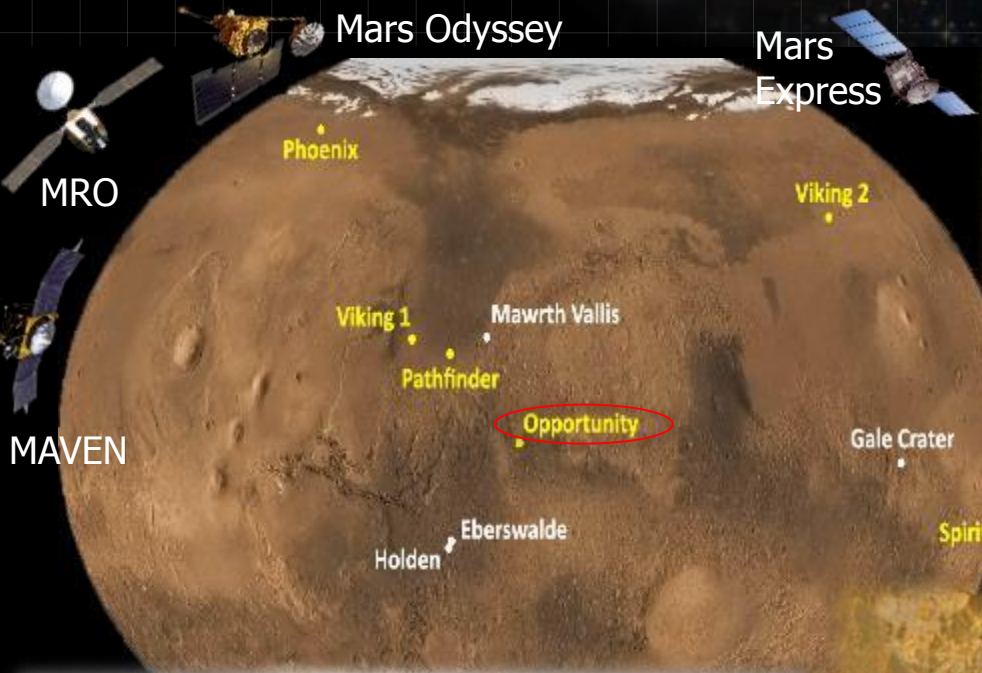
- SLS – Space Launch System
  - Estimated 80-120 metric tons capacity
  - First launch planned for 2017



Cargo and Crew Vehicle



# Planetary Missions, Mars is busy!...



MSL- Mars Science Laboratory  
"Curiosity"



MSL Selfie

MER  
Mars Exploration  
Rover—  
"Opportunity"



Mars Orbiter Views Curiosity Rover  
in 'Artist's Drive'



<http://www.space.com/16874-where-did-nasa-spacecraft-land-on-mars-video.html>

# Many, many other cool missions...

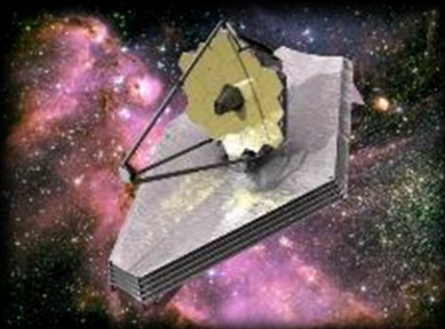


Just a few to mention...



Cassini

Saturn orbit, last year of operation



James Webb Telescope

Launch in 2018

Dawn

Visiting Ceres (arrived March 6 2015)



Hubble

Still researching origins of the universe

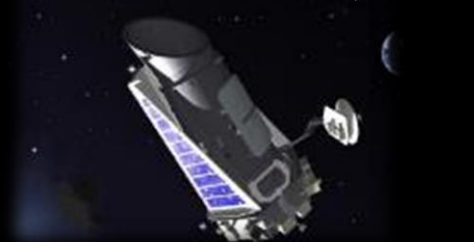


Kepler

Planet Count

Confirmed Planets: 977

Planet Candidates: 4,234



Voyager 1

Has left the building...

Traveling interstellar space



Eyes on the Solar System

<http://eyes.nasa.gov/>

# New Horizons @ Pluto!



- New from NASA's New Horizons: Increasing Variety on Pluto's Close Approach Hemisphere, and a 'Dark Pole' on Charon

NASA's New Horizons spacecraft doesn't pass Pluto until July 14 – but the mission team is making new discoveries as the piano-sized probe bears down on the Pluto system.

## NEW HORIZONS LORRI IMAGES OF PLUTO

CLOSEST APPROACH  
HEMISPHERE

OPPOSITE  
HEMISPHERE

ROTATIONAL  
AXIS



JUNE 5, 2015

PLUTO CENTRAL  
LONGITUDE: 200°



JUNE 8, 2015

PLUTO CENTRAL  
LONGITUDE: 39°



JUNE 12, 2015

PLUTO CENTRAL  
LONGITUDE: 175°

JUNE 13, 2015

PLUTO CENTRAL  
LONGITUDE: 79°

JUNE 18, 2015

PLUTO CENTRAL  
LONGITUDE: 197°



JUNE 15, 2015

PLUTO CENTRAL  
LONGITUDE: 356°

## NEW HORIZONS LORRI IMAGES OF CHAF

JUNE 18, 2015



ORIGINAL

DECONVOLVED

CHARON CENTRAL  
LONGITUDE: 17°

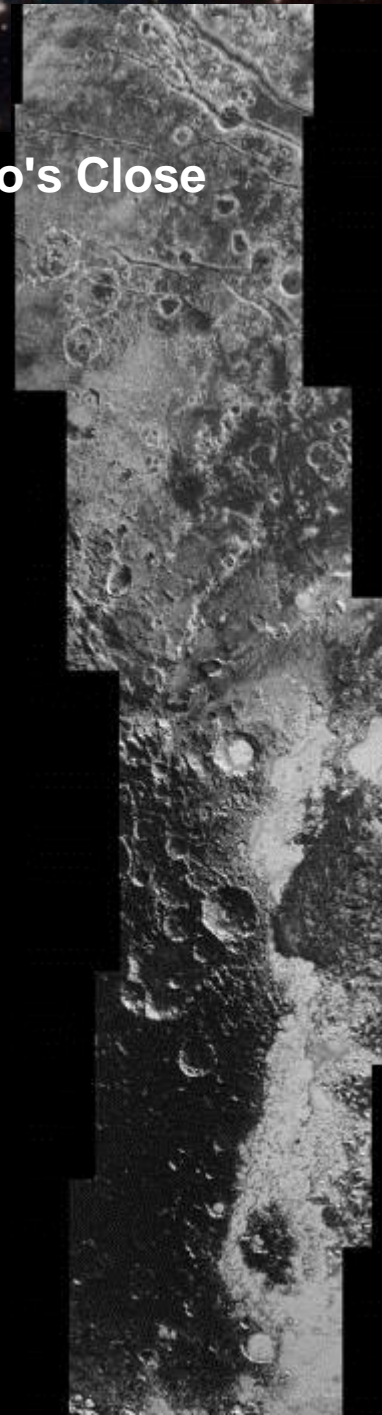
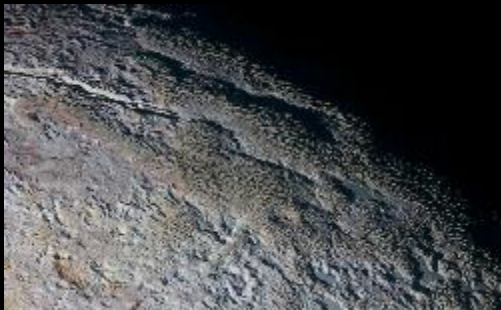
DISTANCE: 31,500,000 KM  
(19,500,000 MILES)

ARRIVAL IN: 28 DAYS

# New Horizons @ Pluto!

- New from NASA's New Horizons: Increasing Variety on Pluto's Close Approach Hemisphere, and a 'Dark Pole' on Charon

NASA's New Horizons  
spacecraft doesn't passed  
Pluto in July 2015–

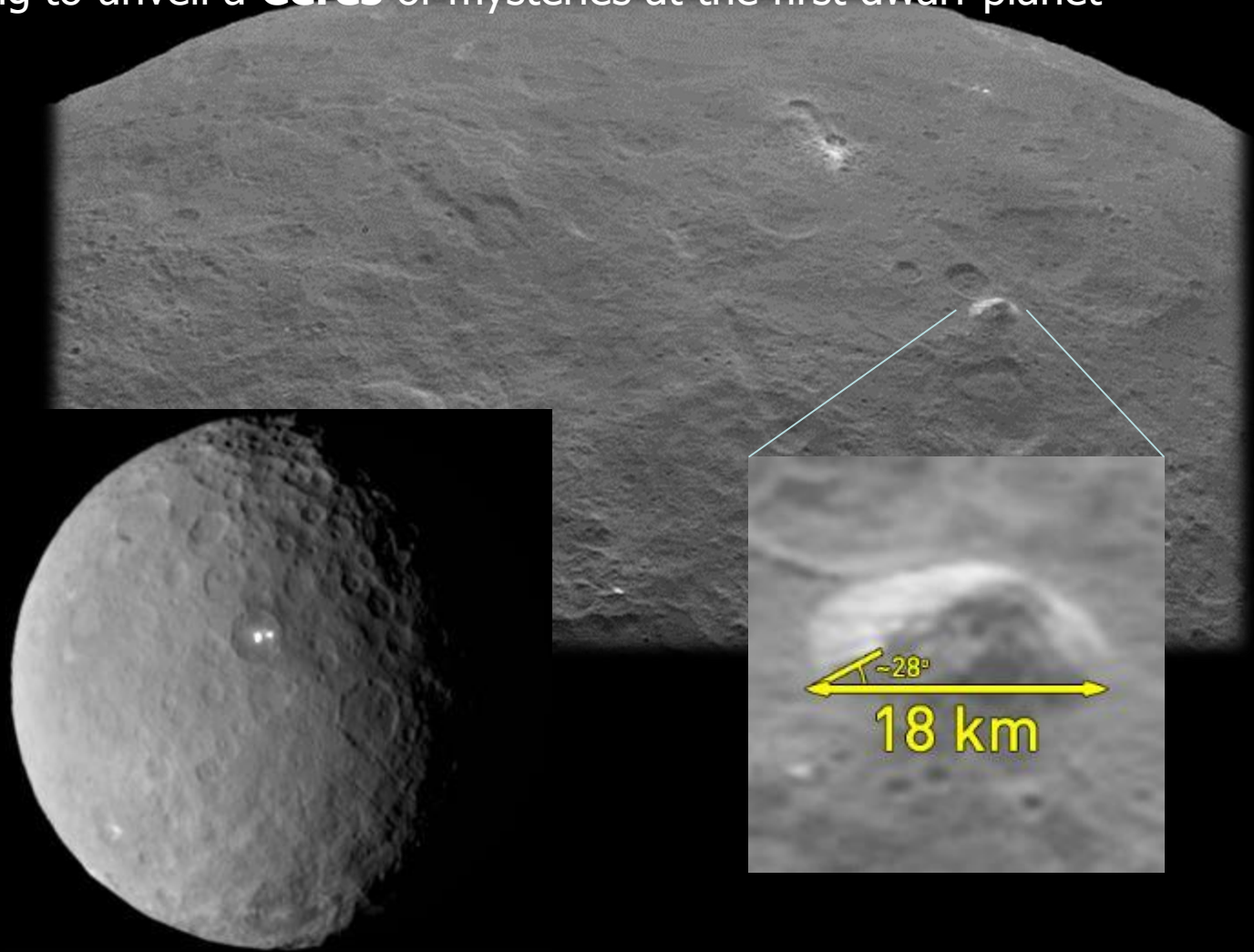


# Dawn Spacecraft @ Ceres



**Dawn** is continuing to unveil a **Ceres** of mysteries at the first dwarf planet discovered

**Dawn** spacecraft has found several more bright spots as well as a pyramid-like peak jutting out of the frigid world's surface



# Caltech Researchers Find Evidence of a Real Ninth Planet



- Caltech researchers have found evidence of a giant planet tracing a bizarre, highly elongated orbit in the outer solar system.
  - The object, which the researchers have nicknamed Planet Nine, has a mass about 10 times that of Earth
- Planet 9 may orbit about 20 times farther from the sun on average than does Neptune (which orbits the sun at an average distance of 2.8 billion miles).
  - In fact, it would take this new planet between 10,000 and 20,000 years to make just one full orbit around the sun
  - Source: <https://www.caltech.edu/news/caltech-researchers-find-evidence-real-ninth-planet-49523>



# NASA's Kepler Discovers First Earth-Size Planet In The 'Habitable Zone' of Another Star



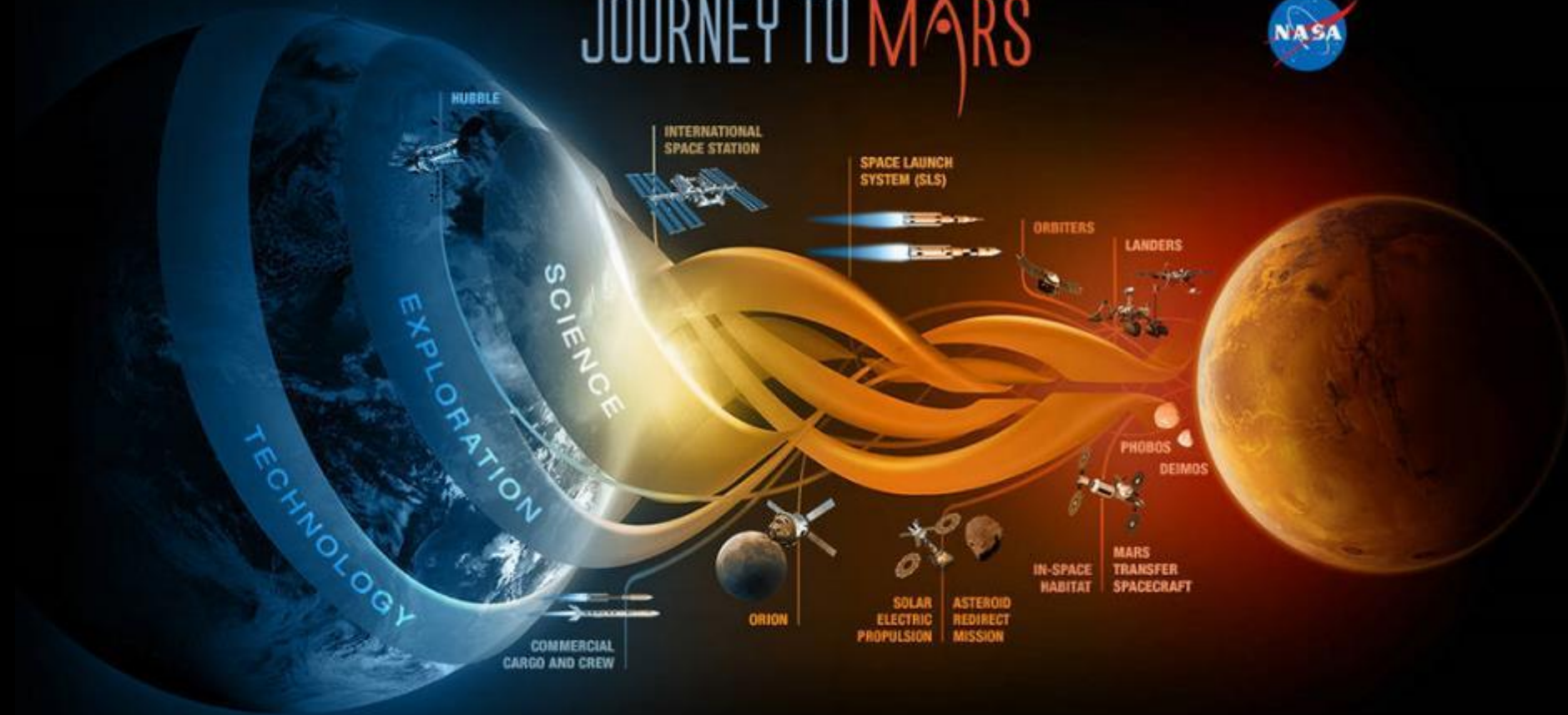
- NASA's Kepler mission has now confirmed the first near-Earth-size planet in the “habitable zone” around a sun very similar to our star.\_
- For more information about this latest discovery, visit: [NASA's Kepler Mission Discovers Bigger, Older Cousin to Earth.](#)



# NASA Journey to Mars



## JOURNEY TO MARS





# Extravehicular Activity (EVA) Hardware & Operations Overview

---

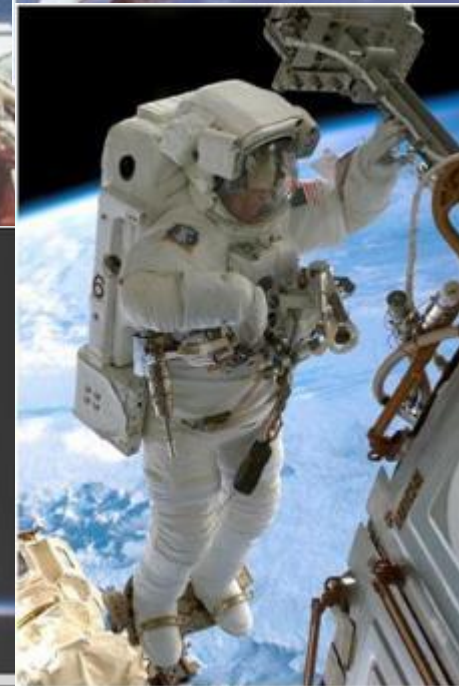
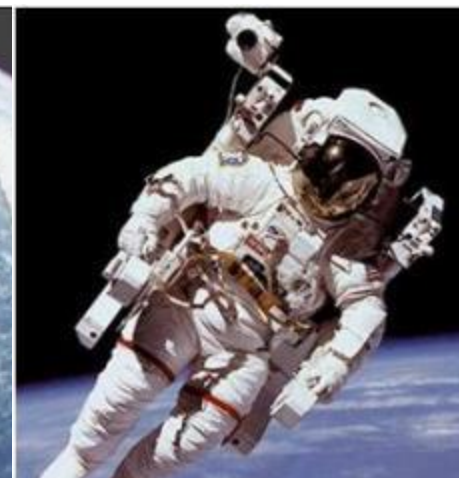




# Definition of EVA



- Extravehicular Activity (EVA)
  - Definition: Crewmember leaves the protective environment of a pressurized spacecraft cabin and ventures out into vacuum of space wearing an extravehicular spacesuit.
  - Purpose
    - Contingency or Mission Success Repairs
    - Experiments or Testing
    - Spacecraft Servicing
    - Space Structure Construction [e.g., International Space Station (ISS)]





# Definition of Spacesuits



- Spacesuits

- Typically, 2 types of pressurized “spacesuits” have been constructed to support our space programs

- Launch, entry, and abort (LEA) spacesuit
  - Used to protect crewmembers from launch, ascent, abort, landing and other dynamic loading
  - Capable of providing protection from loss of cabin pressure and crew rescue following landing.



Launch/Entry Suit



EVA Suit

- ➔ • Extravehicular Activity (EVA) spacesuit
  - Used to allow crewmembers to work effectively in the harsh external space environment (provides protection from vacuum, thermal, micrometeoroids, radiation, etc.).



# Historical Overview



- First EVA was conducted by USSR/Alexi Leonov on March 18, 1965.
  - Many EVAs have since been accomplished by the Soviet Union & Russia continuing into the International Space Station era.



• [http://images.search.yahoo.com/search/images;\\_ylt=A2KJkPo2y.xPWkgAsWOJzbkF?p=voskhod+airlock&fr=yfp-t-701&ei=utf-8&n=30&x=wrt](http://images.search.yahoo.com/search/images;_ylt=A2KJkPo2y.xPWkgAsWOJzbkF?p=voskhod+airlock&fr=yfp-t-701&ei=utf-8&n=30&x=wrt)



# Historical Overview



## U.S. EVA Experience

### • Gemini EVA Experience -

- Astronaut Edward White II performed first U.S. EVA during Gemini IV June 3, 1965 (22 min).
- Term “Spacewalk” coined
- Start of EVA program was excursion to perform a special set of procedures in a new and hostile environment.
- Proved EVA to be a viable technique for operations outside the spacecraft crew compartment.
- Problems encountered: helmet fogging, overheating due to high metabolic activity (primarily due to suit constraints and lack of training).
- Gemini Extravehicular Spacesuit and Life Support
  - 5-layer Gemini spacesuit was intended primarily for Intravehicular Activity (IVA).
  - 2 additional layers were added for EVA (making 7 layers total).
  - An umbilical was used to tether the EVA crewmember to the spacecraft and to supply breathing oxygen.
- 5 Gemini missions involved nine EVAs for a total of **12 hours and 22 minutes** of EVA.

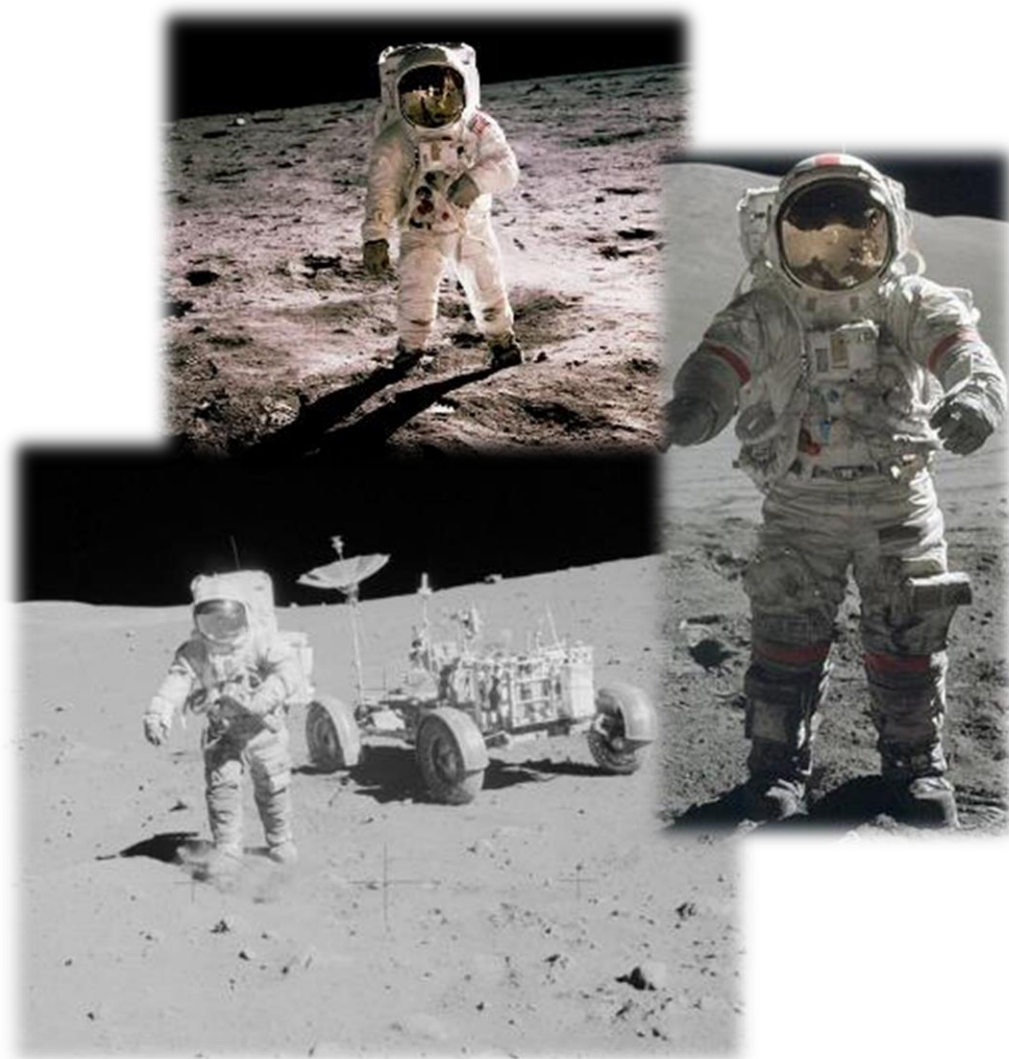




# Historical Overview



- Apollo EVA Experience
  - Spacesuit was redesigned to allow greater mobility.
  - Suit used for lunar and in-space EVAs.
  - Suit was configured with its own portable life support system providing:
    - Pressurization & Atmosphere
    - Communication
    - Ventilation
    - Cooling
    - Waste management system
  - 7 EVA missions totaling **170 hours** of EVA (15 on lunar surface, 5 outside Crew Module).
  - Last 3 Apollo missions (15, 16, & 17) utilized the lunar rover vehicle for greater range in lunar exploration.

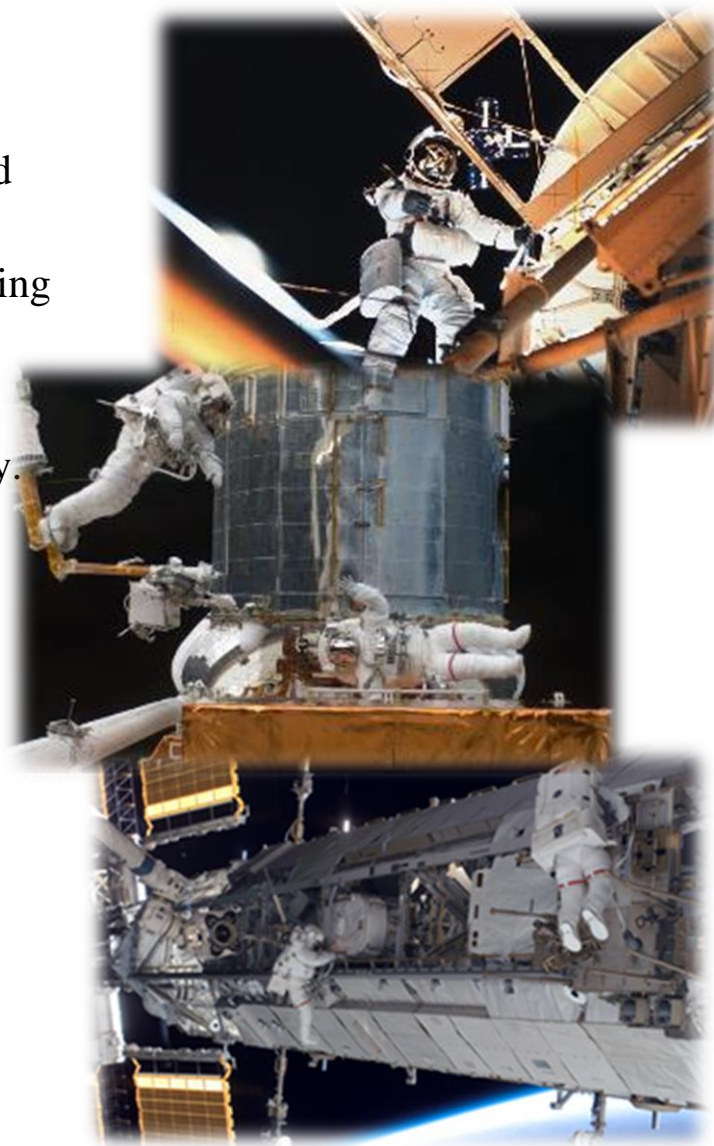




# Historical Overview



- Skylab EVA Experience
  - Apollo-style suit used.
  - Umbilical replaced portable life support system and provided breathing oxygen, cooling, and served as a tethering device.
  - 10 EVAs were performed during the 3 Skylab missions totaling 82.5 hours.
- Space Shuttle EVA Experience
  - New space suit design for additional mobility and modularity.
  - Portable life support system designed for microgravity operation.
  - Increased operational capability from orbiter.
  - Accumulated 1000s of hours of EVA experience over 200+ EVAs.
- Space Station EVA Experience
  - EMU certified for extended duration on-orbit operations (25 EVAs).
  - Orbital Replacement Unit (ORU) capability added.
  - Accumulated 1000s of hours of EVA experience over 150+ EVAs.





# EVA Categories

## ISS & Shuttle Terminology



- Three basic categories of EVA:

1. Scheduled EVA:

EVA planned and trained prior to launch and included in the mission timeline.

- Both 'skills-' and 'task-based' training used

2. Unscheduled EVA:

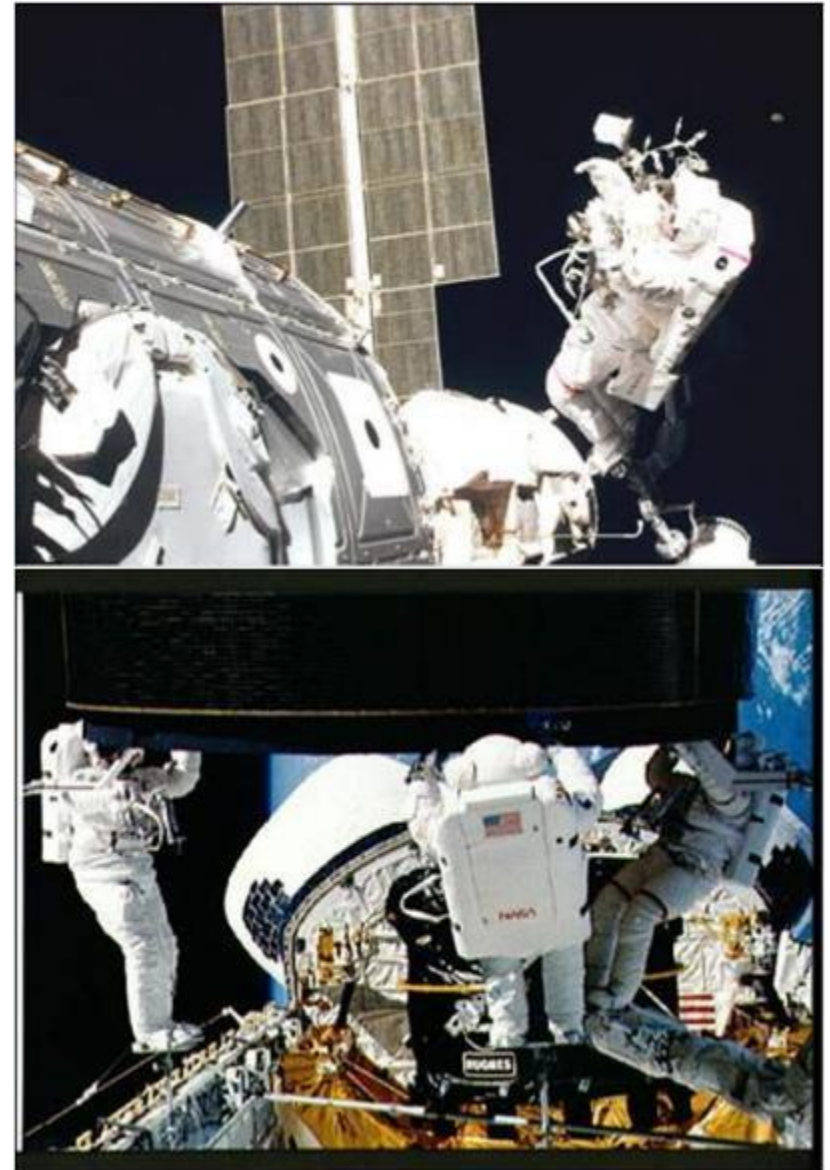
EVA, although trained, not included in the scheduled mission activities, but which may be required to achieve mission or operational success.

- Both 'skills-' and 'task-based' training used

3. Contingency EVA:

EVA required to effect the safety of the crew and vehicle.

- 'Skills-based' training used





# US EVA Systems



- Extravehicular Mobility Unit (EMU)
- ISS Joint Airlock
- Equipment & Tools (including Simplified Aid For EVA Rescue (SAFER))

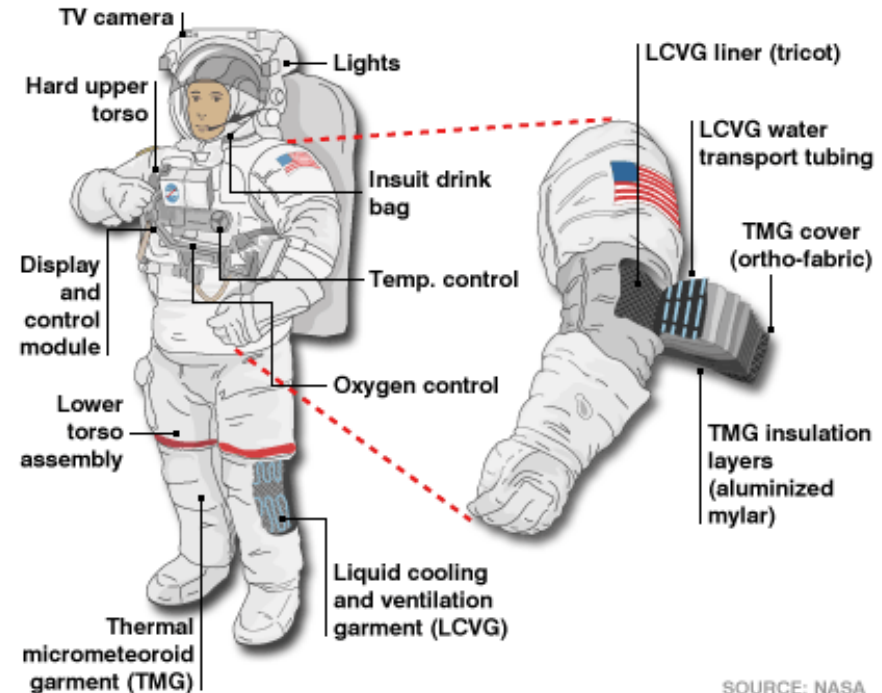




# EVA Systems - EMU



- The EMU is an independent system that provides the crewmember with environmental protection, mobility, life support, and communications during EVA.
- EMU provides consumables to support an EVA of 7 hours maximum duration.
  - 15 minutes for egress
  - 6 hours for useful work
  - 15 minutes for ingress
  - 30 minutes for reserve
- EMU is an integrated system consisting of two subassemblies:
  - Space Suit Assembly (SSA)
  - Portable Life Support System (PLSS)



•orbiterchspacenevents.blogspot.com

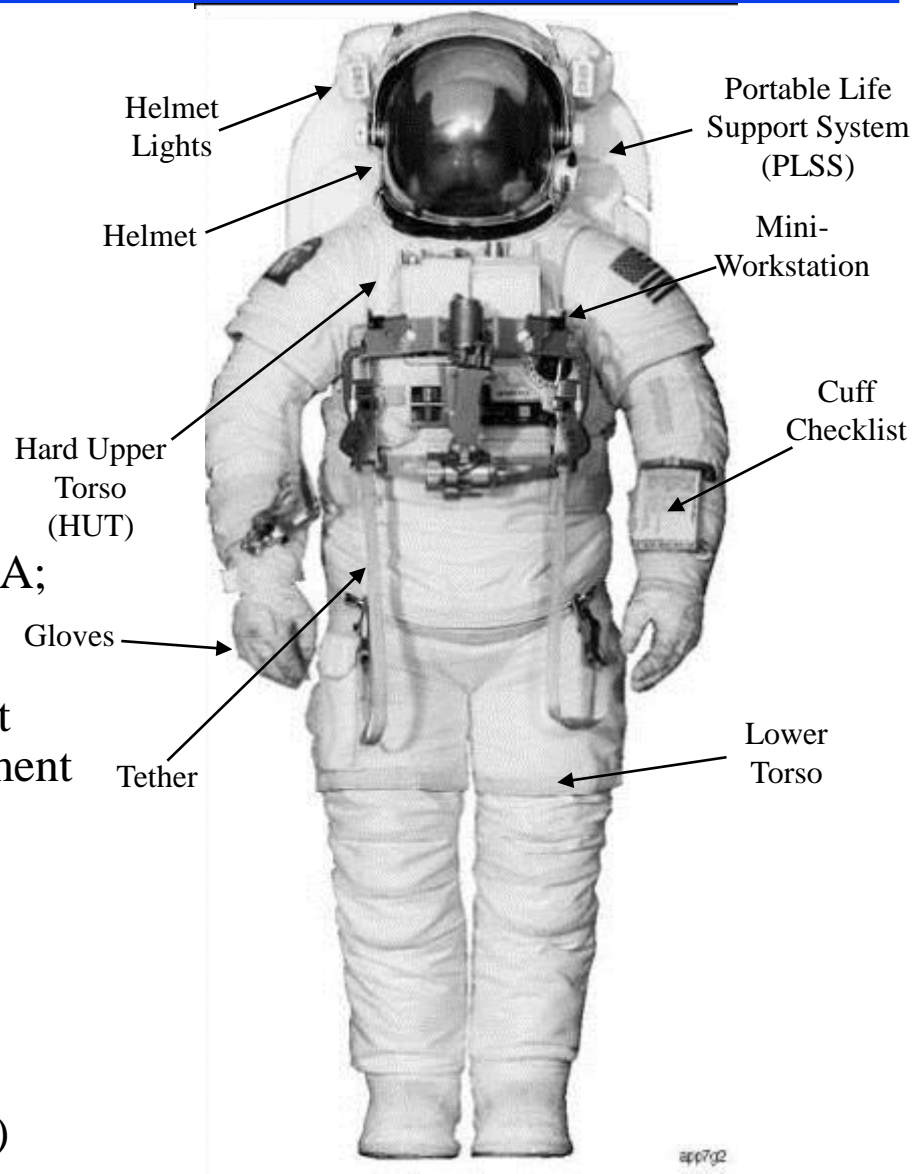


# EVA Systems – Space Suit Assembly



- Space Suit Assembly Components:

- Hard Upper Torso (HUT)/arms
- Lower Torso Assembly (LTA)
- Extravehicular (EV) gloves
- Helmet/Extravehicular Visor Assembly (EVVA)
- Communications Carrier Assembly (CCA; Comm Cap)
- Liquid Cooling and Ventilation Garment (LCVG) / Thermal Cooling Under-Garment (TCU)
- Operational Bioinstrumentation System (EKG)
- Disposable In-Suit Drink Bag (DIDB)
- Maximum Absorption Garment (MAGs)





# EVA Systems – Space Suit Assembly



- Extravehicular (EV) gloves

- Extravehicular (EV) boots (and insert)

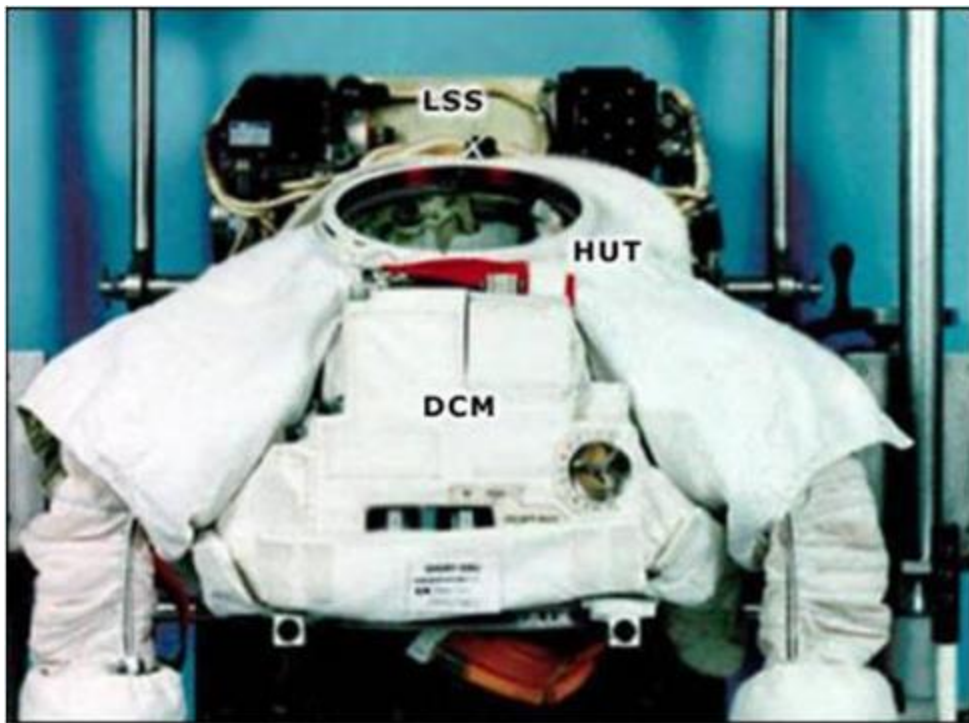




# EVA Systems – Life Support

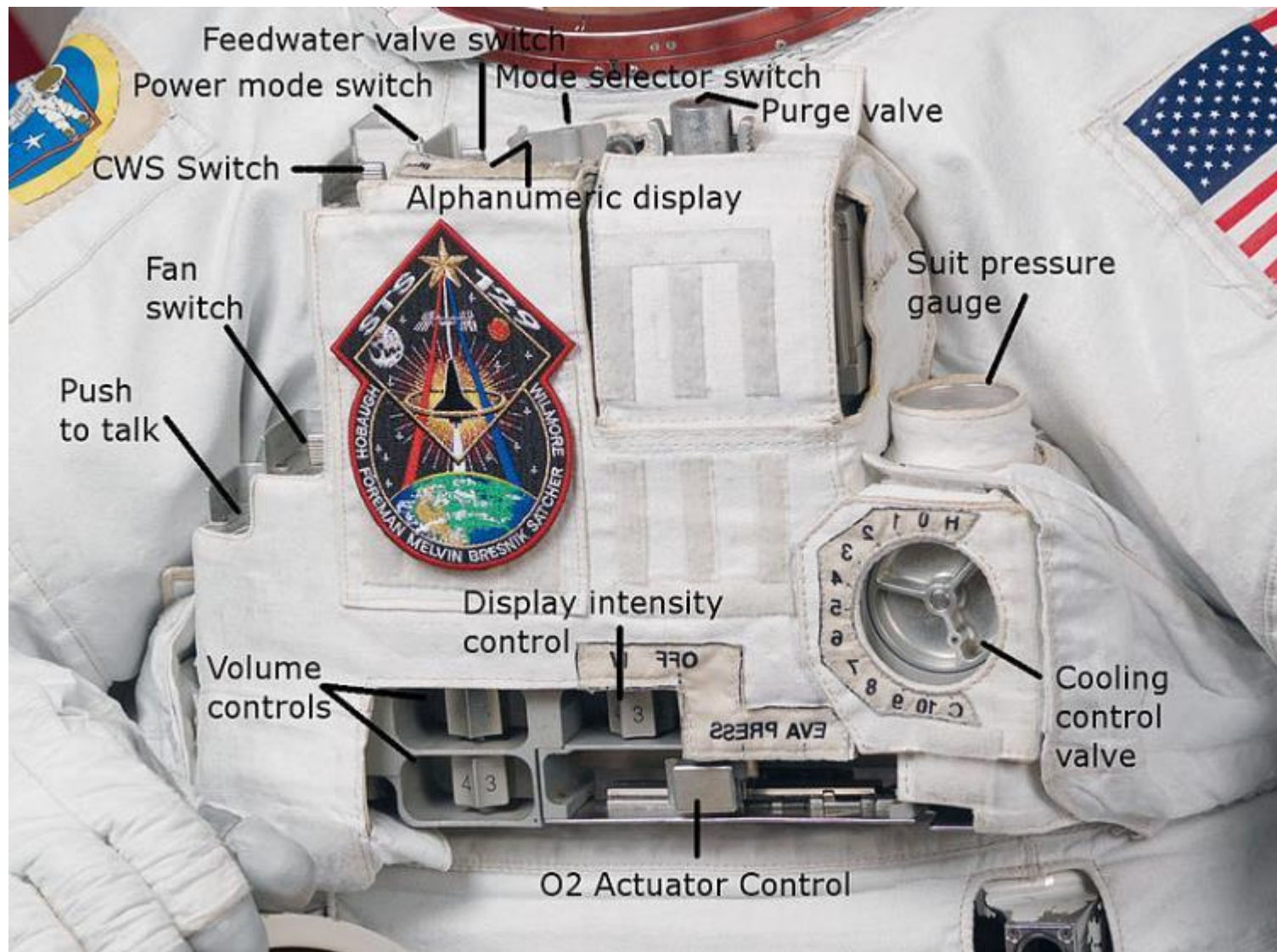


- Life Support System Components:
  - Display and Control Module (DCM)
    - Provides Caution & Warning System (CWS) messages, EMU parameters, and EMU controls to crewmember





# Display Control Module

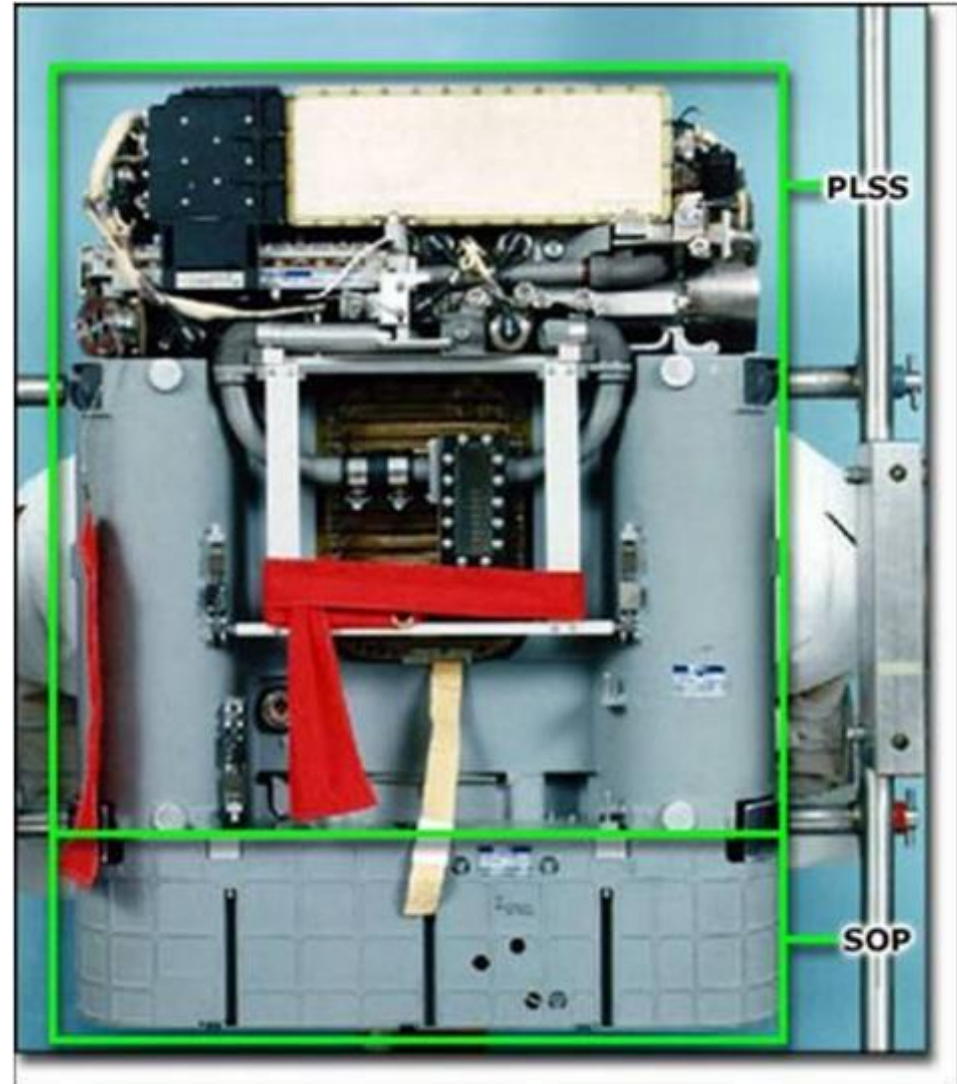




# EVA Systems – Life Support



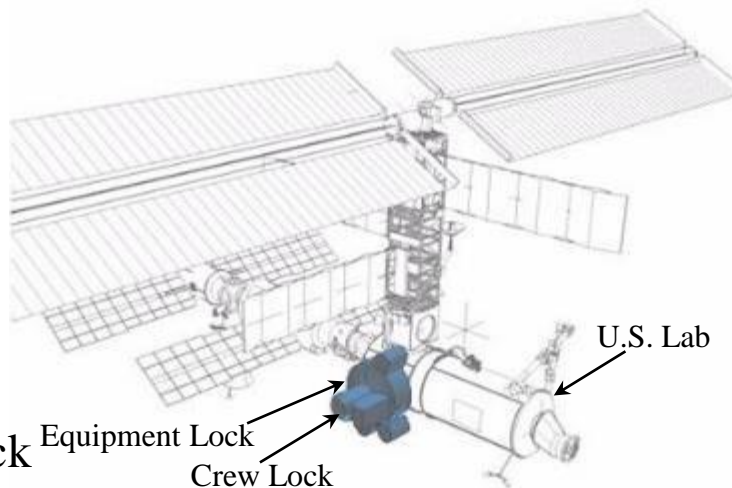
- Life Support System Components:
  - Portable Life Support Subsystem (PLSS)
    - Provides breathing  $O_2$ , electrical power, communications, cooling
    - Responsible for suit pressure control
    - Circulates  $O_2$  and removes  $CO_2$ , humidity and trace contaminants
    - Controls thermal environment
  - Secondary Oxygen Package (SOP)
    - Provides a minimum of 30 minutes of emergency  $O_2$  in open-loop purge mode
    - Activated automatically during EVA, if necessary





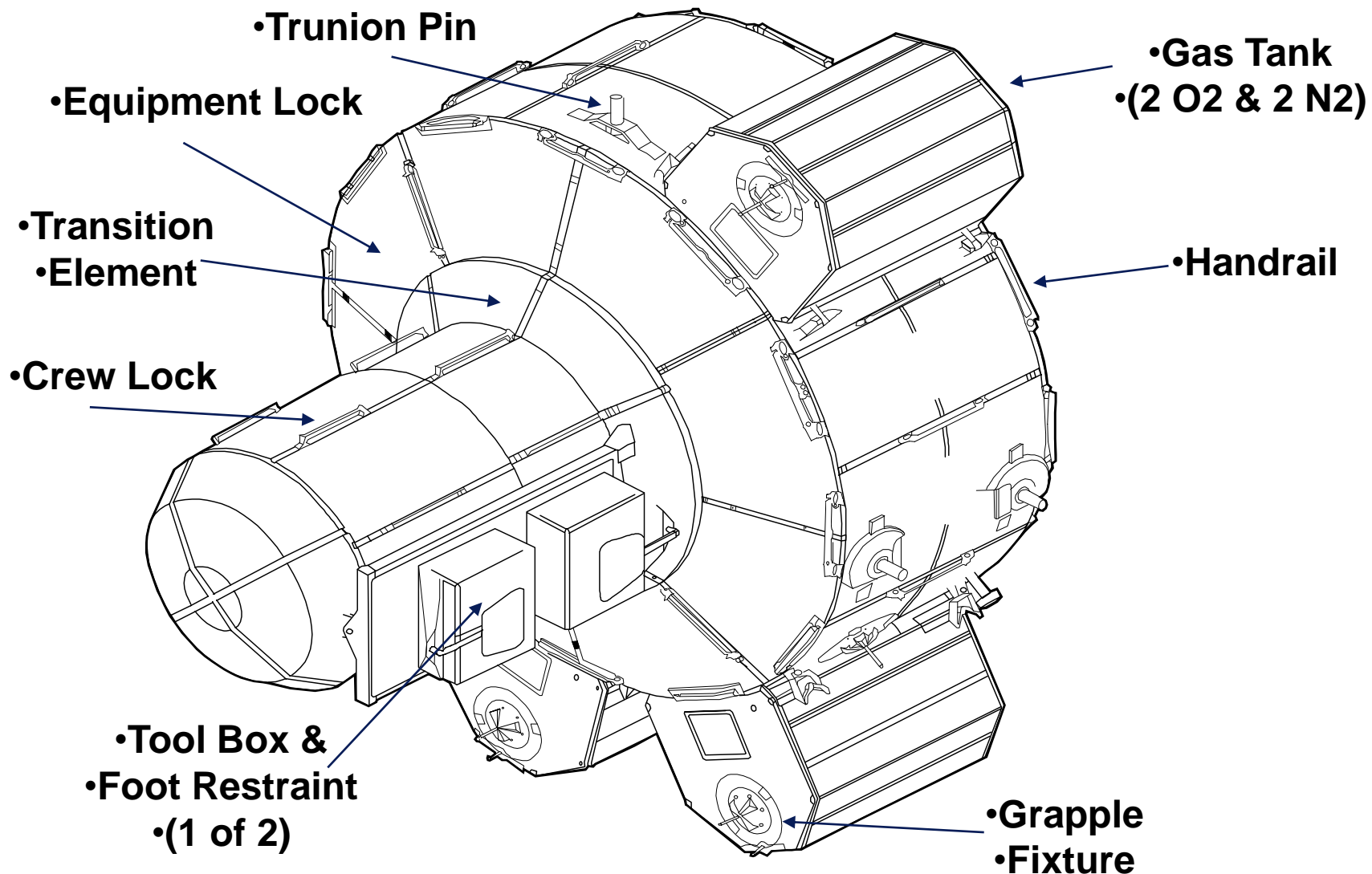
# EVA Systems - ISS Joint Airlock

- ISS Joint Airlock:
  - Primary for U.S. ISS EVAs (both Orbiter and Station-based)
  - Compatible for use with Russian Orions
  - Made up of two parts:  
Crew Lock and Equipment Lock
    - Equipment Lock is used for stowage, recharge and servicing of EMUs and to don/doff the EMUs
    - Crewlock is the volume nominally depressed to vacuum for crew to go EVA



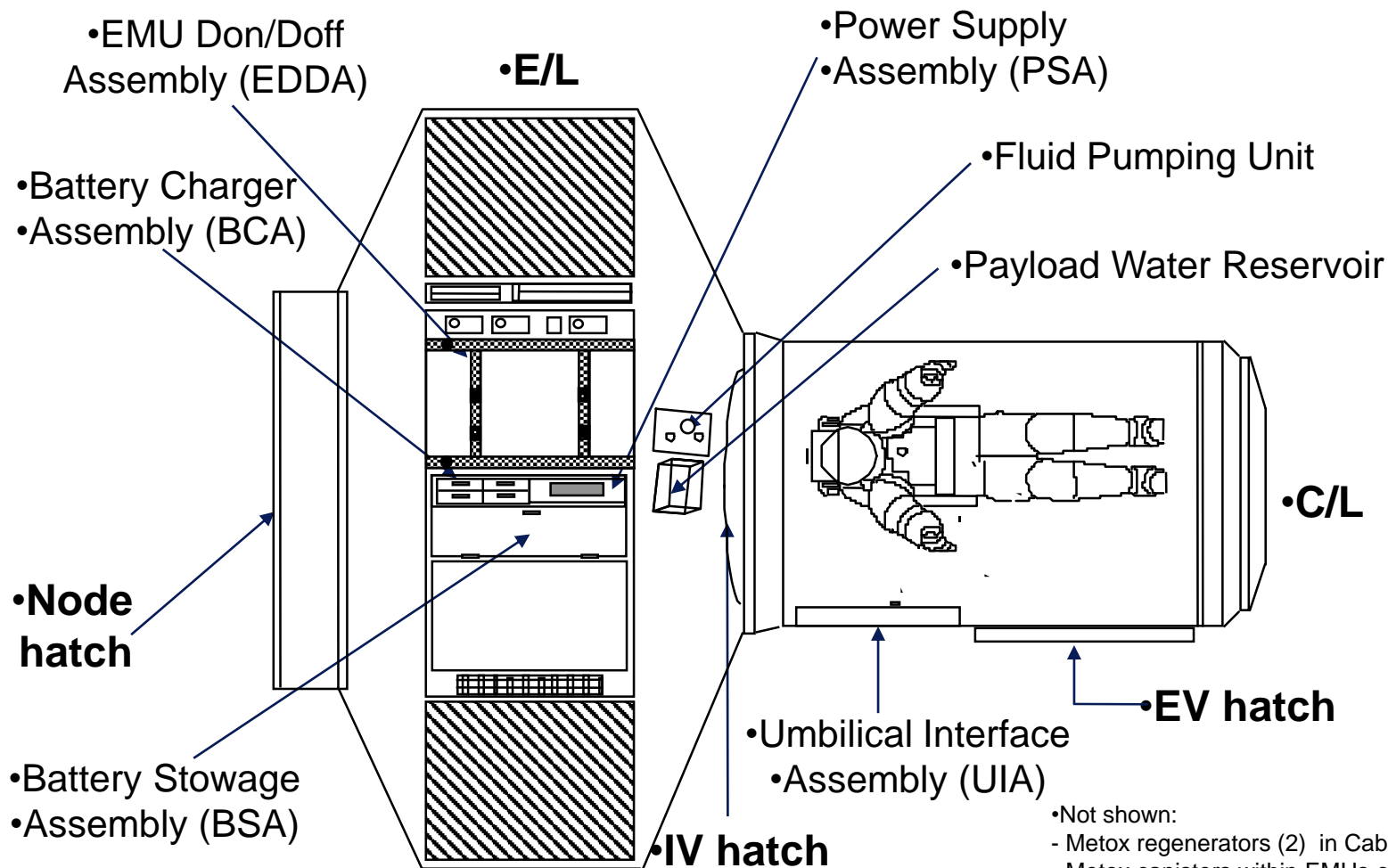


# •International Space Station (ISS) Joint Airlock





# •International Space Station (ISS) Joint Airlock

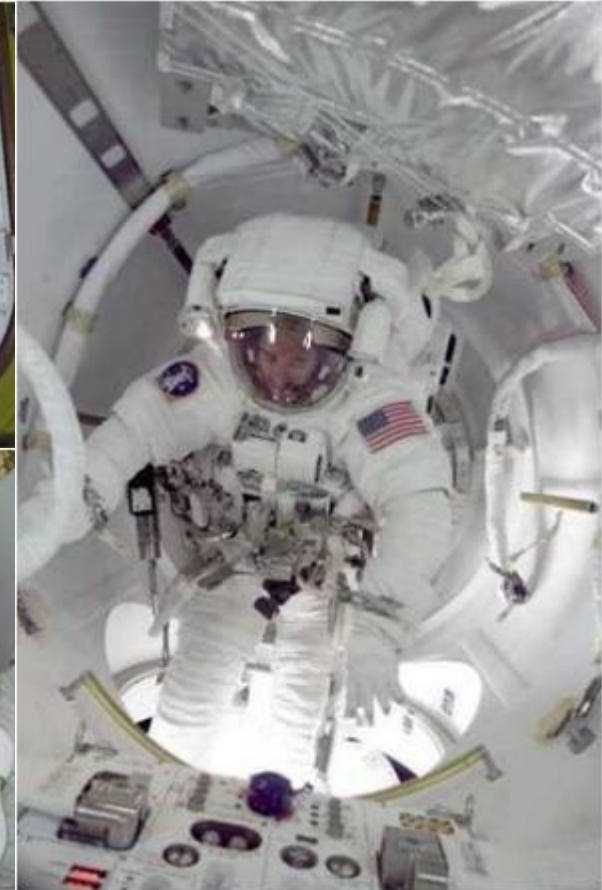


•Not shown:

- Metox regenerators (2) in Cabin Air Rack
- Metox canisters within EMUs or Metox regenerators
- Oxygen Recharge Compressor Assembly (ORCA) in overhead platform
- Russian Depressurization Pump



# EVA Systems - ISS Joint Airlock



**STS-104 / Flight 7A**  
(Summer 2001)



# EVA Systems - ISS Joint Airlock



- PSA
- Battery Charger
  - EMU Battery



# EVA Equipment & Tools



- EMU-mounted tools & equipment

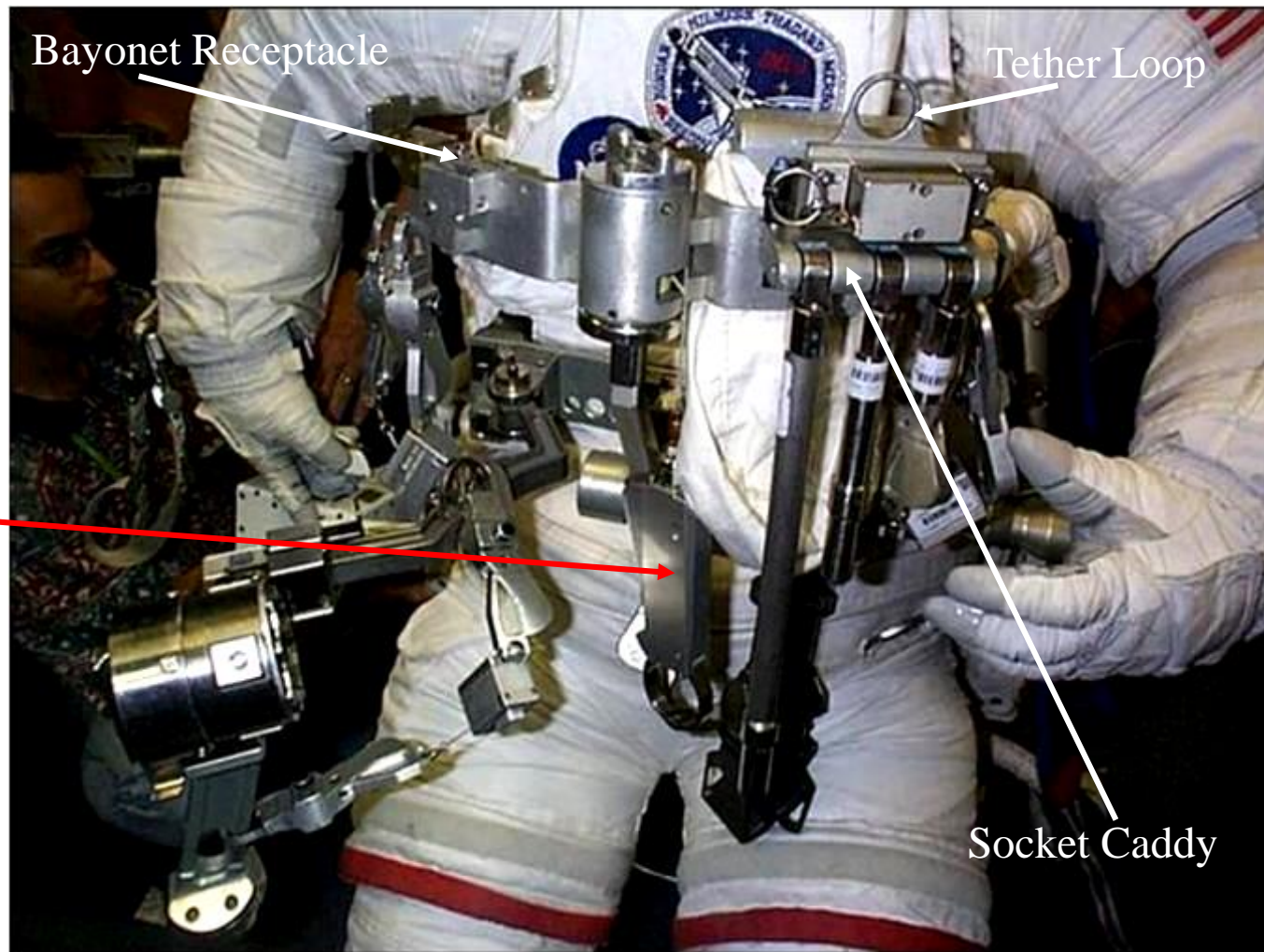
- TV Camera
- Lights
- Mini-workstation
- Waist tethers
- EVA Cuff Checklist
- Wrist mirror
- Body Restraint Tether
- Pistol Grip Tool (PGT)
- ISS Small Trash Bag





# EVA Equipment & Tools

- Mini Work Station (MWS)
  - Attaches to front of the EMU
  - Used to carry small tools
  - Tools are secured via tether rings or via bayonet receptacles
  - MWS end-effector with retractable tether provides restraint to EVA Crewmember at worksite



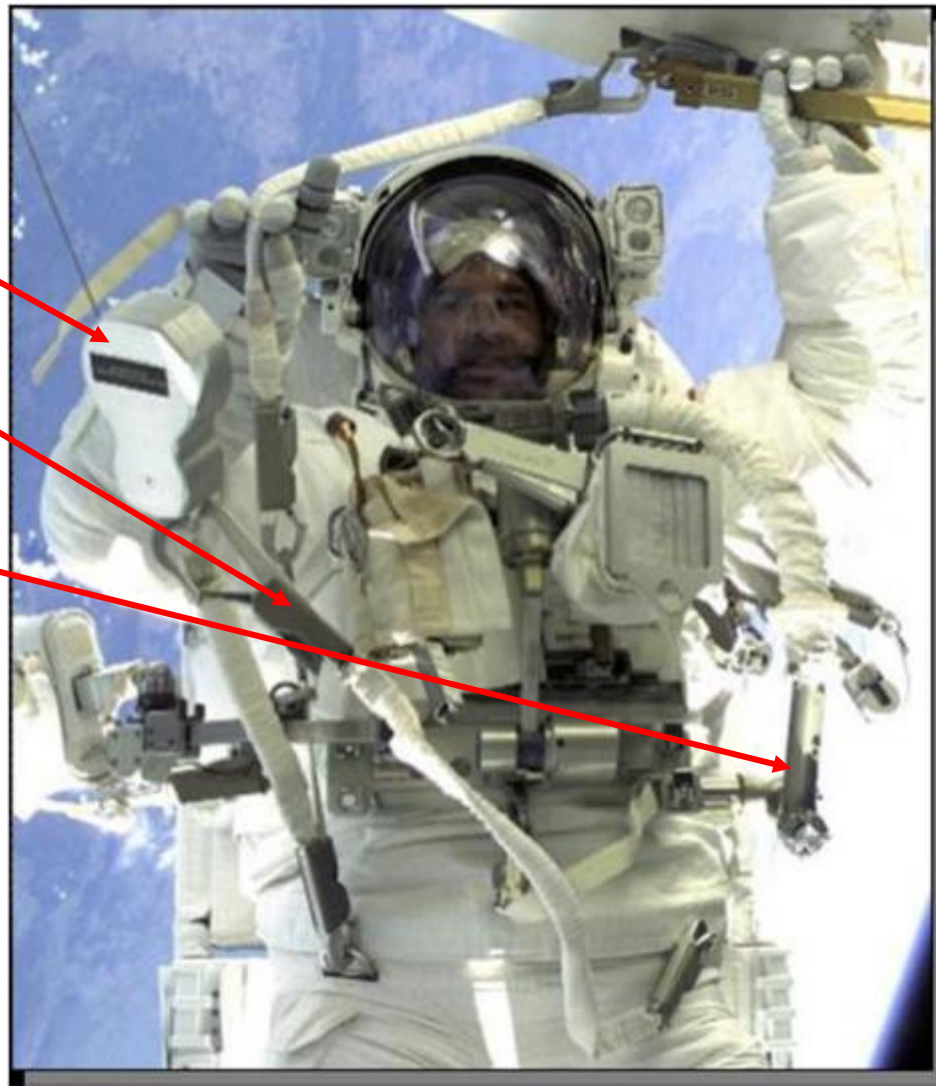
- Note: “Drop-proof tether” PIP pins are used to secure certain items such as a socket onto a tool caddy.



# EVA Equipment & Tools

- Commonly Used Tethers

- Safety Tether (55' and 85')
  - Used to secure the EVA crewmember to the vehicle
- Suit tethers (Waist, Wrist)
  - Used to secure small items to the suit, usually for transfer
- Retractable EVA Tether (RET)
  - Used to secure small items, usually while item is in use
- Body Restraint Tether (BRT)
  - Attaches to the Mini-Work Station (MWS)
  - End-effector provides semi-rigid restraint to EVA crewmember at worksite via handrail (also used for translating small objects)
  - Requires less time than setting up a Portable Foot Restraint and is more stable than a MWS end effector
- Note: EVA tether protocol is that crewmembers and equipment must be tethered at all times
  - Always **make** a connection before you **break** a connection.





# EVA Systems - SAFER (Simplified Aid for EVA Rescue)

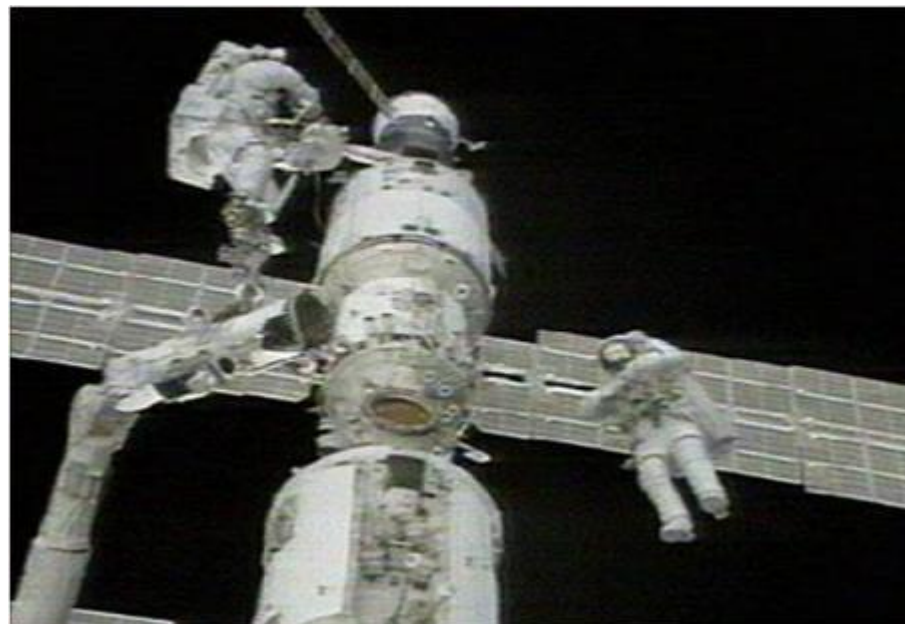
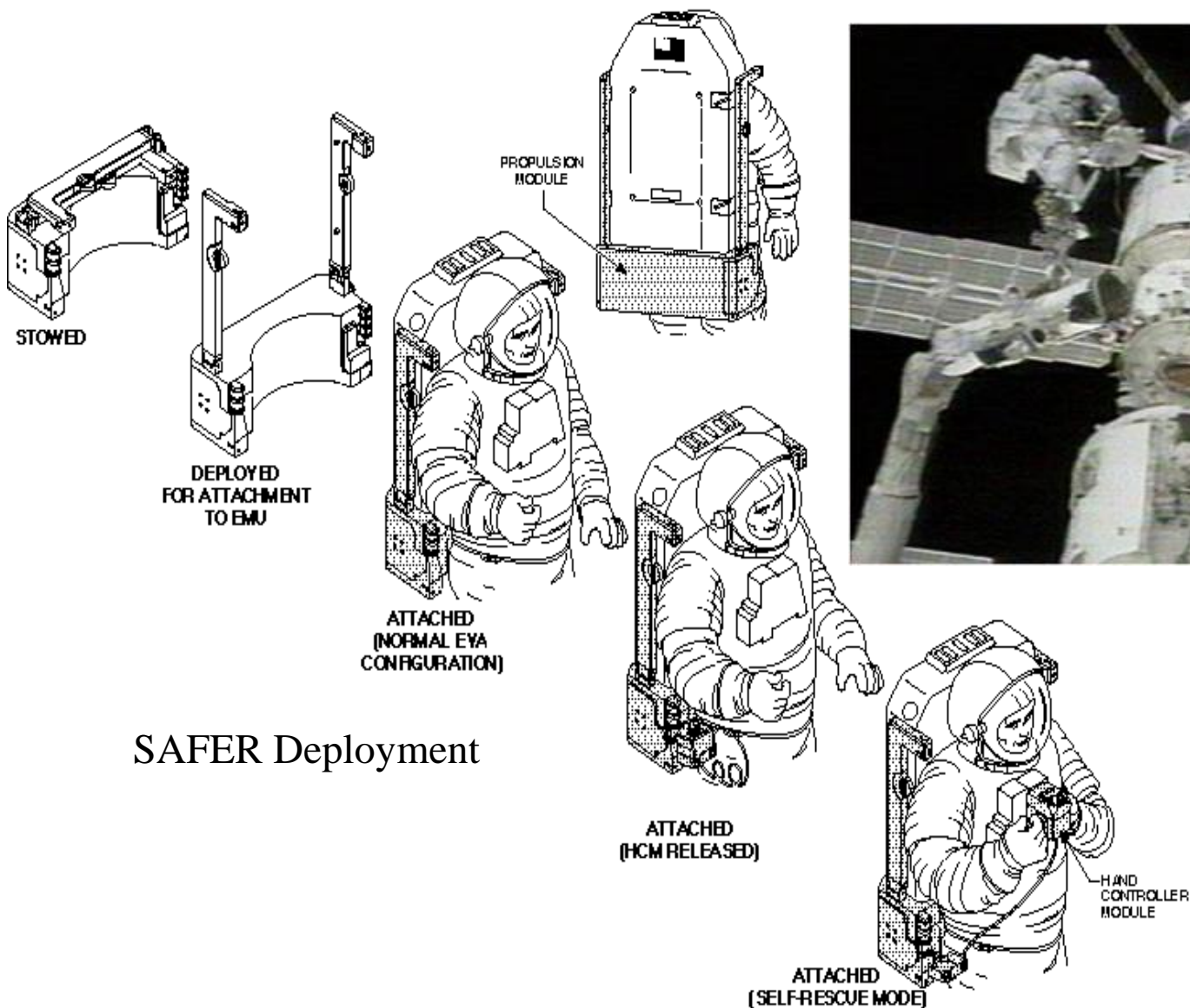


- SAFER is a self-contained, propulsive backpack self-rescue system that provides the EV crewmember with self-rescue capability when the orbiter is not present or cannot immediately perform EVA rescue.
  - Propellant: Pressurized nitrogen gas
  - Controlled by a single hand controller
  - Stowed in ISS Airlock, used on ISS EVAs
  - Sufficient propellant and power for one self-rescue (~13 min)
  - Test flight on mission STS-64; self-rescue capability on STS-76
  - Power up of production model SAFER on STS-86
  - Tethered test flight of production model SAFER on Flights 2A and 3A





# EVA Systems - SAFER (Simplified Aid for EVA Rescue)



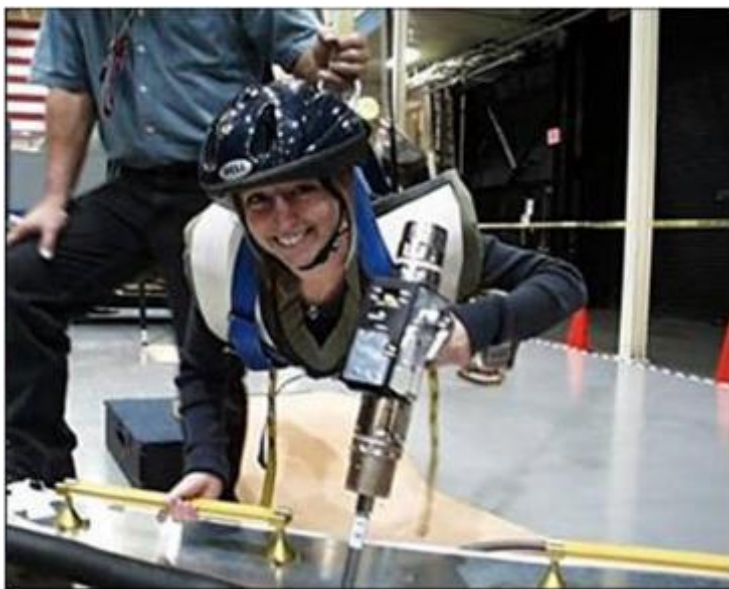
SAFER Deployment



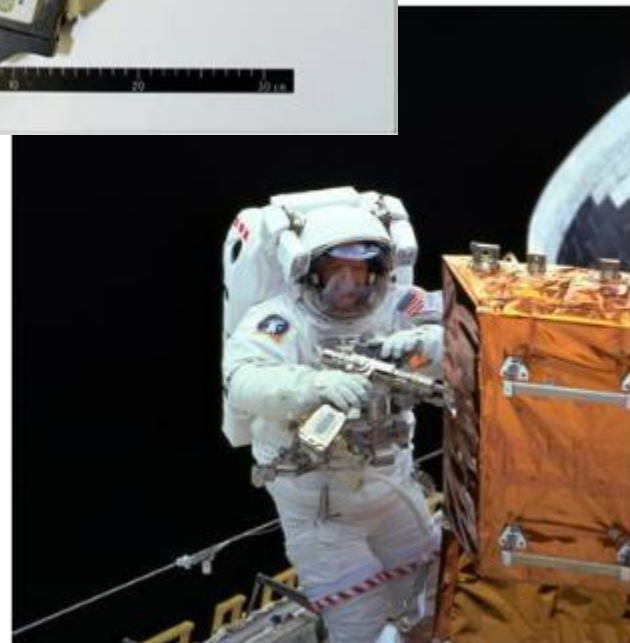
# EVA Equipment & Tools



- Pistol Grip Tool (PGT)
- EVA torque wrench (i.e., a bolt turner)
  - Has a programmable torque limiter and turn limiter
  - Crewmember needs to be secured depending on amount of torque required
  - 2ft-lbs to 25ft-lbs of torque available
  - Generally used for ISS assembly missions and maintenance EVAs



← 1-G Testing  
of the PGT





# EVA Equipment & Tools



- Foot Restraints
  - Attach to structure via a socket
  - Provides EVA crewmember rigid restraint at a worksite (Newton's 3<sup>rd</sup> Law)
- Different types:
  - Portable foot restraint (PFR) (*Shuttle*)
  - Articulating PFR (APFR) (*U.S. ISS*)
  - Interoperable APFR (IAPFR) (*U.S. & Russian ISS*)

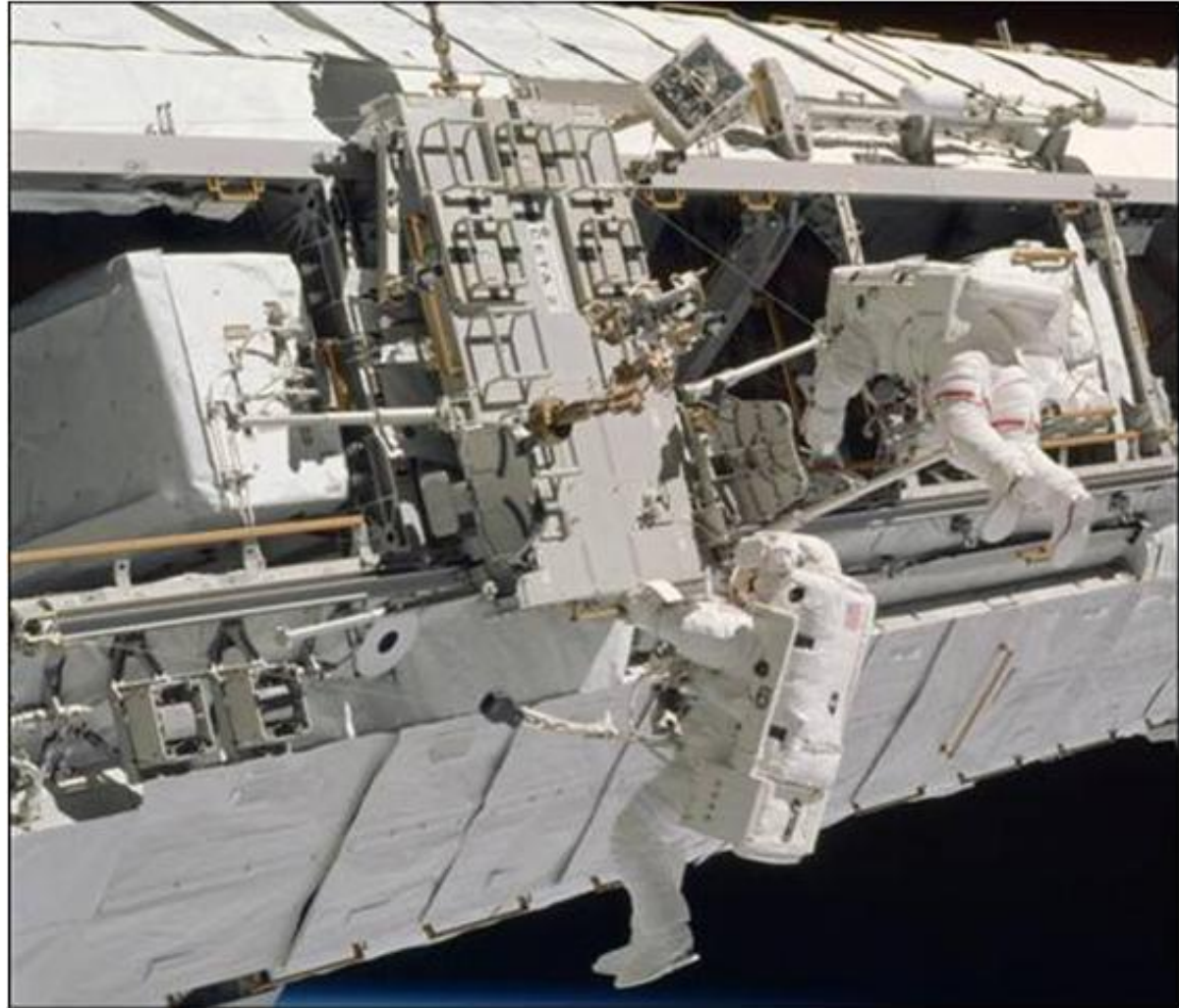




# EVA Equipment & Tools



- Crew and Equipment Translation Aid (CETA) Cart
  - Essentially an EVA equipment cart
  - Translates by CM manually pulling it along truss
  - Use brakes to stop and stay parked
  - Typical use: small ORU replacement on front truss face





# EVA Operations Overview



EVA operations can be divided into three phases:



Pre-EVA



EVA



Post-EVA



# EVA Operations: Overview of Typical EVA



30 min	Airlock depress
15 min	Airlock egress
6 hours	Worksite operations: Shuttle and ISS-based
	– All Shuttle EVA crewmembers are trained to perform the following Orbiter contingency tasks (if necessary) for each flight:
	<ul style="list-style-type: none"><li>• Failed airlock hatch latches or actuator tasks</li><li>• Failed Remote Manipulator System (RMS) tasks</li><li>• Manual stowage of radiators or Ku-band antenna</li><li>• Manual closure of payload bay doors</li><li>• Installation of payload bay door latch tools</li><li>• Manual separation of Shuttle from ISS (96 bolt task)</li></ul>
	– EVA crewmembers assigned to a flight are also trained for scheduled, unscheduled, or contingency tasks.
15 min	Airlock ingress
30 min	Airlock repress



# Comparison of Russian & U.S. EVAs

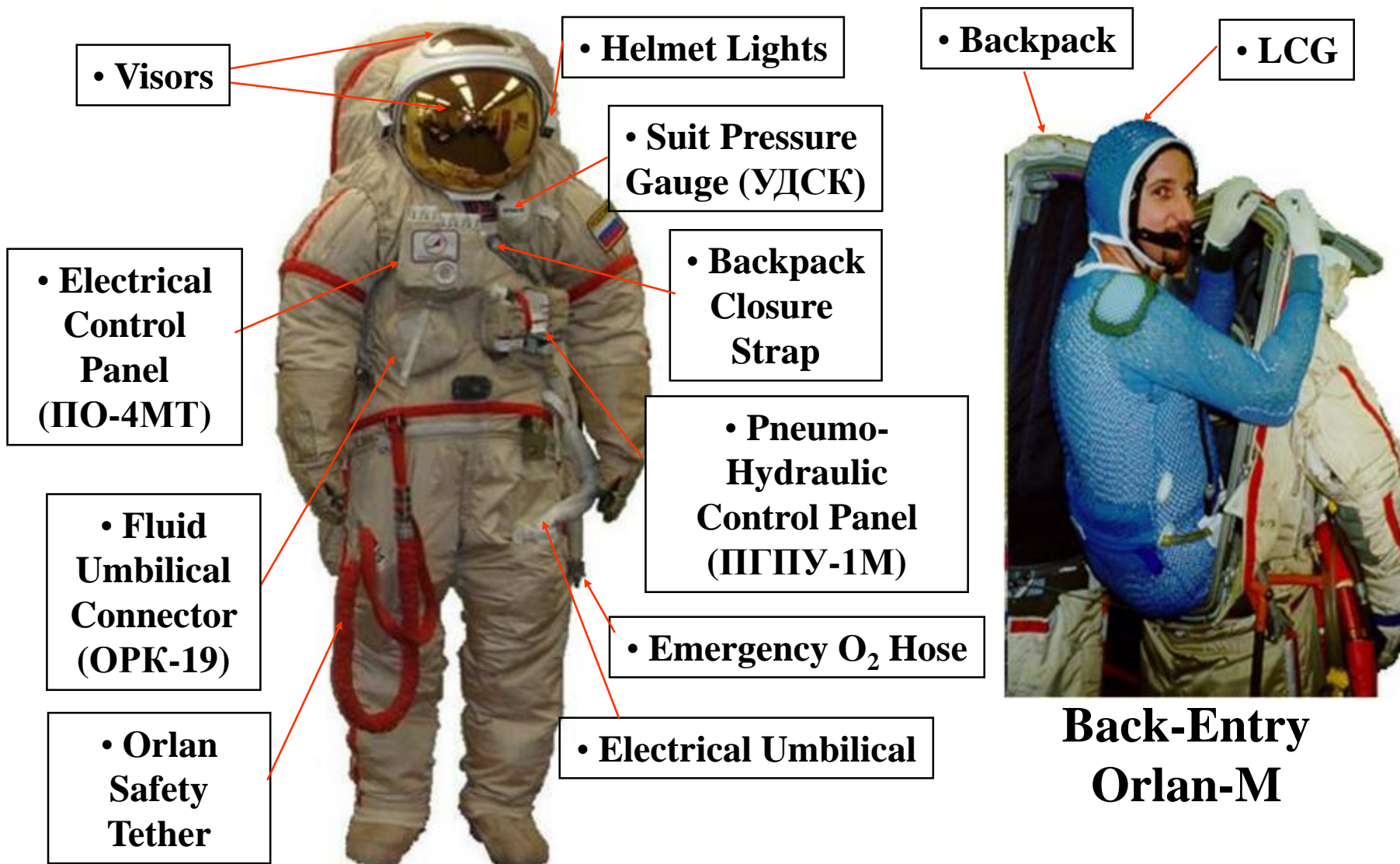


- Russian Orlan-M Spacesuit
- U.S. Extravehicular Mobility Unit (EMU)





# •Orlan-M Spacesuit



**Back-Entry  
Orlan-M**



# • *Suit Enclosure*

• **Helmet Assembly**

• **Upper Arms**

• **Lower Arms**

• **Umbilical Interface**

• **Gloves**

• **Orlan Safety Tethers**

• **Hard Upper Torso**

• **Backpack Closure Strap**

• **Suit Probe**

• **Leg Assembly**

• **Boots**





# EVA Training Facilities



- Space Station Mockup Training Facility (SSMTF) Airlock Mockup





# EVA Training Facilities



- EMU Caution and Warning System (ECWS) Trainer





# EVA Training Facilities



- Vacuum chambers
  - 11-foot chamber
  - Environmental Test Article (ETA) chamber
  - Space Environment Simulation Lab (SESL) chamber
  - Space Station Airlock Test Article (SSATA)





# EVA Training Facilities



- Virtual Reality Lab





# EVA Training Facilities Charlotte for Low Gravity Mass Ops

---



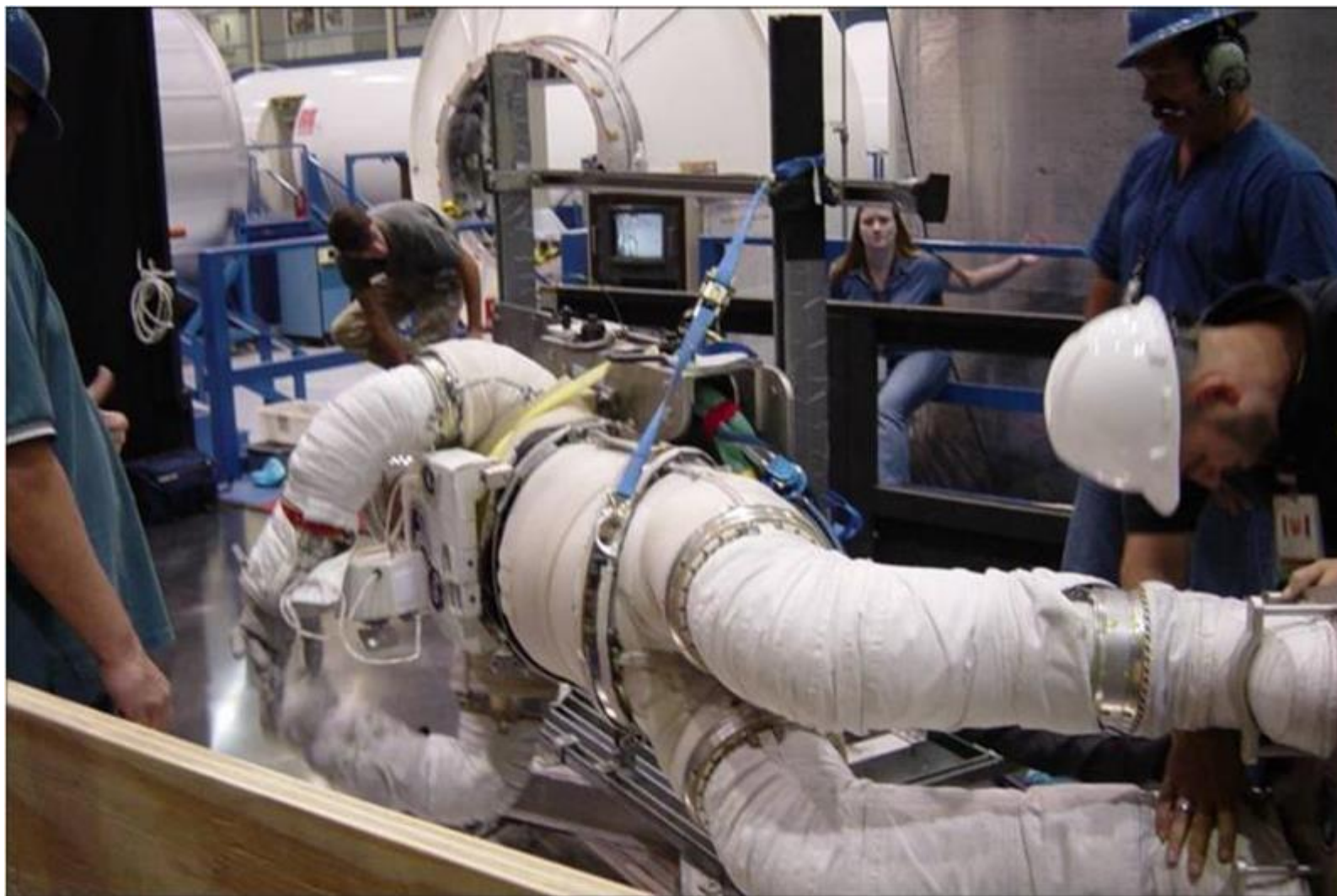
Source : Osterlund, J. & Lawrence, B. 2012



# EVA Training Facilities



- Precision Air-Bearing Floor (PABF)





# EVA Training Facilities



- Neutral Buoyancy Laboratory (NBL)





# EVA Training Facilities

## The Active Response Gravity Offload System (POGO/ARGOS)



- POGO/ARGOS uses an inline load cell to continuously offload of a portion of a human or robotic subject's weight during all dynamic motions



National Aeronautics and Space Administration

# Backup...

8,000 miles



Low Earth Orbit (LEO)

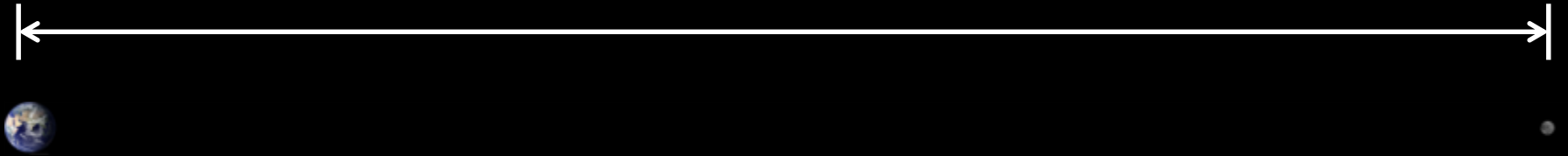
250 miles



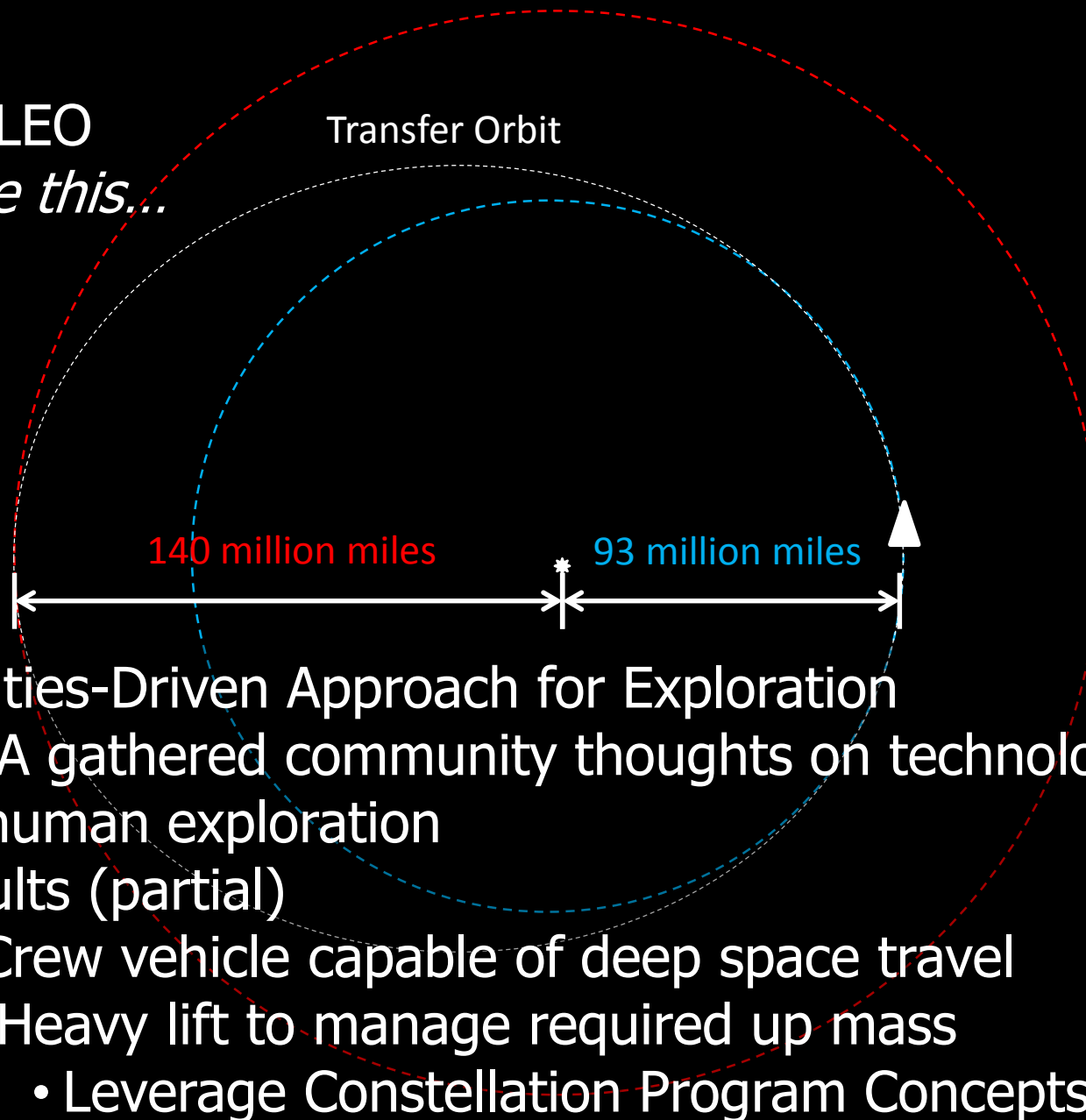
- Continue ISS through 2024
  - Focus on research and using as a test bed for exploration
- Engage commercial industry to service ISS
  - COTS (SpaceX and Orbital Sciences) – today
  - Commercial Crew - competitive programs – 2017?
    - CCDEv (1-2) – Commercial Crew Development
    - CCIcap- Commercial Crew Integration Capabilities
- Goal is to generate sustained commercial LEO industry

# Beyond LEO?

240,000 miles



Beyond LEO  
*More like this...*



- Capabilities-Driven Approach for Exploration
  - NASA gathered community thoughts on technology needs for human exploration
  - Results (partial)
    - Crew vehicle capable of deep space travel
    - Heavy lift to manage required up mass
      - Leverage Constellation Program Concepts (Orion

# Space Exploration Challenges...



- Who would you need on a deep space mission?

## Standard for LEO today

- Pilot
- Scientist
- Engineer

## Required Systems Experts for Exploration Missions

- Propulsion
- Navigation
- Communication
- Environmental (Plumber, AC, Heat)
- Power
- Stowage/Inventory

- Other crew, required?

- Doctor
- Dentist
- Psychologist
- Geologist
- IT/Computer
- Machinist
- Handyman
- Sheriff
- Judge/Lawyer
- Machinist

**20+  
People???**



# Space Exploration Challenges...



- Up mass
  - Exploration Vehicle – est. 100 tons of material and supplies (ISS 420 tons)
- Propulsion
  - Chemical, Ion, Solar Electric
- Environmental Systems
  - Closed loop, Reliability, Redundancy
- Automation
  - Self maintaining systems
- Radiation Shielding
  - Crew and systems health
- Communication
  - Comm delays increase
- Long Range Human Health Affects
  - Bone health, eye damage, long term radiation exposure
- Stowage/Logistics



**Questions?**

**Thank You!**



# My favorites...

# My favorite sites and links...



- Heavens Above
  - <http://heavens-above.com/>
- NASA Spinoffs
  - <http://spinoff.nasa.gov/>
- Eyes on the Solar System
  - <http://eyes.nasa.gov/>
  - Youtube NASA Television
    - <http://www.youtube.com/user/NASAtelevision>
  - Youtube Earth Video
    - <http://www.youtube.com/watch?v=lp2ZGND1I9Q>
  - ISS Tour by CDR/Suni Williams
    - <http://www.youtube.com/watch?v=doN4t5NkW-k>
  - Why Mars is Hard Stan Love
    - <http://www.youtube.com/watch?v=fturU0u5KJo>
- Perspectives
  - <http://htwins.net/scale2/?bordercolor=white>
- ISSLive
  - <http://spacestationlive.jsc.nasa.gov/>
- Distance Learning Network
  - NASA DLN Website: <http://www.nasa.gov/offices/education/programs/national/dln/index.html>
  - Toolkit with Material and Templates:  
<http://communications.nasa.gov/OCP/Communications%20Tool%20Kit/Presentation%20Template%20Web%20Site/CTK.html>



# JPL – Eyes on the Solar System

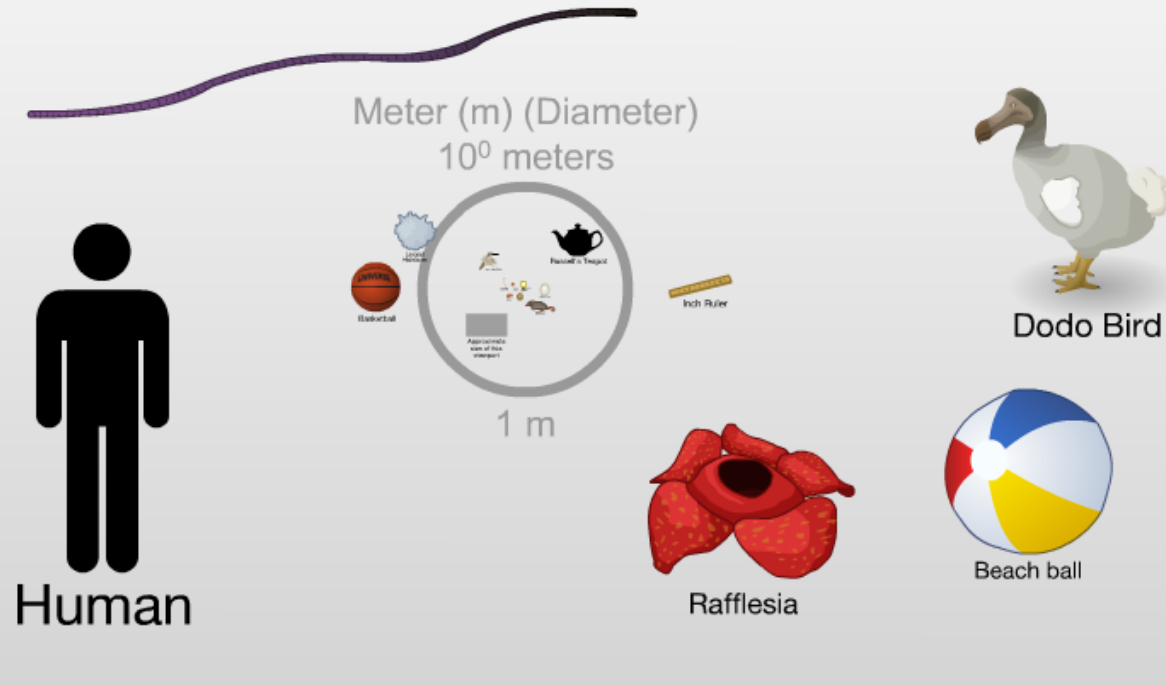


Eyes on the Solar System

<http://eyes.nasa.gov/>

<http://htwins.net/scale2/?bordercolor=white>

## Giant Earthworm



Copyright © 2012 Cary and Michael Huang (<http://htwins.net>)

Other languages

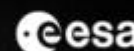
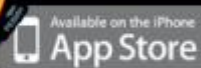
Back

# ISSLive



ISSLive

<http://isslive.com/>



# Youtube – REELNASA



## ReelNASA

[http://www.youtube.com/results?search\\_query=reelnasa&sa=X&spell=1&search=Search&oi=spell](http://www.youtube.com/results?search_query=reelnasa&sa=X&spell=1&search=Search&oi=spell)

A screenshot of a YouTube search results page. The search bar at the top contains the text "reelnasa". Below the search bar, it says "Filter" and "About 990 results". The first result is a channel named "Reel NASA" with a video thumbnail showing a person in a space suit. The second result is a video titled "Science off the Sphere: Knitting Needle Experiment" with a thumbnail showing a bright light in a dark space. The third result is a video titled "We Are the Explorers" with a thumbnail showing a colorful nebula. The fourth result is a video titled "Chase Plane Video Of Historic SpaceX Splashdown" with a thumbnail showing a plane in the sky. The fifth result is a video titled "Science off the Sphere: Goo!" with a thumbnail showing a yellow substance in a container. The sixth result is a video titled "Interview with NASA Earth Scientist Melissa Davares" with a thumbnail showing a person in a space suit.

**You Tube** reelnasa Browse | Mov

Filter ▾ About 990 results

**Reel NASA**  
Get off my planet. Give me my space. Get real with **Reel NASA**. Space trav ...  
ISS Update: Dr. Steve Squyres, NEEMO 16 Aquanaut and Cornell Professor  
CHANNEL by ReelNASA | 928 videos | 31,508 subscribers

**Science off the Sphere: Knitting Needle Experiment**  
challenge and view future experiments here: www.physicscentral.com ... **Reel NASA** ...  
"Science off the Sphere" "American Physical Society" "Don Pettit" ...  
CC by ReelNASA | 4 months ago | 546,686 views

**We Are the Explorers**  
is helping us lay the foundation for our greatest journeys ahead. ... **Reel NASA** ... NASA  
exploration "Peter Cullen" space flew shuttle station Orion ...  
HD CC by ReelNASA | 3 months ago | 176,084 views

**Chase Plane Video Of Historic SpaceX Splashdown**  
berth with the International Space Station, paving the way for future commercial cargo delivery  
flights. ... **Reel NASA** ... 120601 SpaceX ...  
HD by ReelNASA | 3 weeks ago | 70,754 views

**Science off the Sphere: Goo!**  
challenge and view future experiments here: www.physicscentral.com ... **Reel NASA** ...  
"international space station" "expedition 31" "don pettit" ...  
CC by ReelNASA | 1 month ago | 8,412 views

**Interview with NASA Earth Scientist Melissa Davares**

# NASA Spinoffs



<http://spinoff.nasa.gov/>



## Office of the Chief Technologist

Value for NASA, Benefits for the Nation

### NASA Spinoff



Home

About Spinoff

Request a Spinoff

Be In Spinoff

Spinoff Database

Spinoff FAQ

Contact Us

Connect with NASA Spinoff



Partnership with NASA



[NASA Online Partnering Tool](#)



#### What is NASA's Investment in America's Future?

Jeopardy! host Alex Trebek shares how NASA spinoffs provide tangible benefits for the Nation.

NASA @ Home and City



Find a trace of outer space in your home and city.

[View Feature](#)

Spinoff Tweets



NASA Spinoff

**NASASpinoff**

# Heavens Above



<http://heavens-above.com/>

Heavens-Above Home Page - Windows Internet Explorer

http://heavens-above.com/

File Edit View Favorites Tools Help

Favorites HomeDO4 Flight Planning Br... wVU engineering - Bing HomeDO4 Flight Planning Br...

Heavens-Above Home Page x ISSLive! Bringing the Interna...

Find: biconic Previous Next Options

 [Aerospace](#)  
Earn an Aerospace degree online at American Public University System.  
[www.APUS.edu/Aerospace](http://www.APUS.edu/Aerospace) AdChoices

### Configuration

Current observing site: **Clear Lake, 33.0781°N, 96.4950°W**  
[select from map](#) or [from database](#) or [edit manually](#)  
[Registered user login](#) | [Why register?](#)  
[Create new user account](#)

### Satellites

10 day predictions for: [ISS](#) | [Tiangong 1](#)  
[Genesis-1 / 2](#) | [Envisat](#) | [HST](#)  
[Select another satellite](#) from the database  
Daily predictions for all satellites brighter than magnitude:  
(brightest) 3.5 | 4.0 | 4.5 (dimmiest)  
All passes of [ISS](#) - including daylight and invisible passes.  
Iridium Flares  
[next 24 hrs](#) | [next 7 days](#) | [previous 48 hrs](#)  
Daytime flares for 7 days - see satellites in broad daylight!  
[Spacecraft escaping the Solar System](#) - where are they now?  
[Radio amateur satellites](#) - 24 hour predictions (all passes)  
[Height of the ISS](#) | [Phobos Grunt](#) - how does it vary with time

### Astronomy

Comets currently brighter than mag. 12  
[189P NEAT](#) | [96P Machholz](#) | [C/2009 P1 Garrard](#)  
Minor planets currently brighter than mag. 10  
[4 Vesta](#) | [1 Ceres](#) | [18 Melpomene](#)  
[Whole sky chart](#)  
[Sun and Moon data for today](#)  
[Planet summary data](#)  
[Planet details \(under construction\)](#)  
[Mercury](#) | [Venus](#) | [Earth](#) | [Mars](#) | [Jupiter](#) | [Saturn](#) | [Uranus](#) | [Neptune](#) | [Pluto](#)  
[Solar system chart](#)



© Heavens-Above.com

Current position of ISS

+1 523


### GPS Fleet Tracking

GPS Tracking Lowers Costs Free, Live Demonstration  
[www.Saoe-Quest.com](http://www.Saoe-Quest.com)

# NASA Distance Learning



NASA DLN Website: <http://www.nasa.gov/offices/education/programs/national/dln/index.html>



HOMENEWSMISSIONSMULTIMEDIACONNECTABOUT NASA

Search

NASA Home > Education > Programs > DLN

SendShare

Digital Learning Network (DLN)

DLN Home

About DLN

Event Catalog

PD & Special Events

Event Guidelines

DLInfo Channel

Technical FAQ


5E Teaching Model

Tools & Plugins

Contact Us

Feedback Forms

Search Event




NASA Digital Learning Network™


DLN sites: Ames, Dryden, Glenn, Goddard, JPL, Johnson, Kennedy, Langley, Marshall, Stennis

A Universe of Possibilities

Welcome to NASA's DLN


NASA's Digital Learning Network™ provides science, technology, engineering, and mathematics or STEM content featuring NASA missions and research. Register for free, interactive events listed in our catalog or watch our webcasts listed below.

 Like us on Facebook!

 Follow us on Twitter!

To assist both new and existing users, we **STRONGLY** encourage you to view our DLN Overview Video and the DLIntro presentation located in [About DLN](#). DLIntro will guide you through our website, show how to register for modules, and explain other services.

DLN Announcements



DLN User

> Sign In

> New User Registration

> New School/Org Registration

> Forgot Password

USDLA Awards NASA's Digital Learning

See the Space  
Station fly over  
**YOUR** home!

Use "Skywatch"  
program  
or go to  
"sightings  
by city"

- [spaceflight.nasa.gov/realdata/sightings](https://spaceflight.nasa.gov/realdata/sightings)

SATELLITE	LOCAL DATE/TIME	DURATION (MIN)	MAX ELEV (DEG)	APPROACH (DEG-DIR)	DEPARTURE (DEG-DIR)
ISS	Tue Nov 14/06:22 AM	4	66	10 above WSW	31 above NE

